

**MULTINATIONAL ENTERPRISES, TECHNOLOGY  
TRANSFER AND SPILLOVERS:  
PANEL DATA EVIDENCE FROM UK  
MANUFACTURING INDUSTRY**

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TRANSFER AND SPILLOVERS:  
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MANUFACTURING INDUSTRY**

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A thesis submitted in partial fulfilment of the requirements of the University of  
Abertay Dundee for the degree of Doctor of Philosophy

**June 2000**


I certify that this thesis is the true and accurate version of the thesis approved by the  
examiners

Signed.  of Studies)

Date...10...10...2000

## Declaration

I hereby declare that while registered as a candidate for the degree for which this thesis is presented I have not been a candidate for any other award. I further declare that, except where stated, the work in this thesis is original and was performed by myself

Sign  (Chengqi Wang)

Date.....06/10/2000.....

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## **List of publications and conference presentations**

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## Abstract

*Technology transfer and spillovers and the role of intangible assets are among the most important issues on the research agenda concerning foreign direct investment (FDI). This thesis examines the relationships between multinational investment, technology transfer, spillovers and economic performance. It does this through econometric analysis using firm level panel datasets from UK manufacturing industries. As such, the work aims to make a contribution to the existing literature on FDI in situations where the host is a developed country. The analysis is essentially broken down into three sub-topics. First, an examination of technology transfer from multinational headquarters to their overseas affiliates is conducted. Next an investigation of spillover effects from foreign affiliates to locally owned firms is undertaken. Finally the thesis compares the performance of foreign subsidiaries with that of their locally owned counterparts.*

*An initial review of the literature in the field establishes a theoretical framework that is useful in setting up the econometric models. Technology is addressed as a key issue with respect to FDI because its transfer has potentially positive benefits for host countries. Since the context of the study involves multinational investment and growth, the theoretical review highlights the role of technology and spillovers in new growth theory. The literature on technology transfer is also helpful. Here the important roles of intangible assets and human capital are highlighted along with the technological capabilities of locally owned firms.*

*Using the theoretical framework, empirical models are developed and several propositions are tested. There are a number of important findings from the econometric analysis. First, technology generated in parent firms is transferred to their UK affiliates. The characteristics of the sending and receiving firm and the technology itself are important determinants of the extent of transfer. Secondly, there are intra-industry productivity spillovers from FDI in UK manufacturing industries and there is evidence that spillover effects are bi-directional. Thirdly, the extent to which local firms benefit from the advanced technology of multinational firms depends on their own technological capabilities. In other words host country benefits from spillovers are negatively related to the technology gap between foreign and locally owned firms. Finally, despite spillover benefits, UK owned firms are still outperformed by their foreign counterparts due to inferior stocks of intangible assets and the failure to exploit scale economies, while the performance of foreign subsidiaries for foreign superiority do vary across nationalities. The thesis draws policy implications from these important findings.*

## List of variables

*LP* is labour productivity and is measured as the ratio of turnover (or value-added) per employee for each firm;

*LPD* is *LP* defined for UK domestically owned firms;

*LPF* is *LP* defined for foreign owned firms;

*CI* is capital intensity and is measured as physical capital stock to employment;

*CID* is *CI* defined for UK domestically owned firms;

*CIF* is *CI* defined for foreign owned firms;

*CP* is capital productivity and is measured as the ratio of value-added to the physical capital stock;

*CR* is concentration ratio and is measured as the share of the industry's turnover accounted for by the largest 5 firms.

*FP* is a proxy for foreign presence and is measured either by the share of capital stock in foreign-owned firms in the total capital stock in the industry, or by the share of employment in foreign-owned firms in total employment in the industry.

*FIA* is the share of intangible assets stock of foreign-owned firms to the employment in UK domestically owned firms in an industry

***GAP*** is technology gap between foreign and UK domestically owned firms and is proxied as the ratio of average labour productivity of foreign-owned to that of UK domestically owned firms in each industry.

***HC*** is human capital intensity and is proxied as the residuals from regression of the log (average wages) on other variables which together as explanatory variables in a equation where the dependent variable is output measured productivity. The measure of HC in this thesis varies from chapter to chapter depending what the productivity equation is used;

***HCD*** is *HC* defined for UK domestically owned firms;

***HCF*** is *HC* defined for foreign owned firms;

***IA*** is intangible assets intensity, and is measured as the ratio of intangible assets stock to employment;

***IAD*** is *IA* defined for UK domestically owned firms:

***IAF*** is *IA* defined for foreign owned firms;

***I*** is an industry dummy:

Food, beverage and tobacco

Textile products

Leather products

Wood products

Pulp, paper and publishing

Coke, petroleum and nuclear

Chemical products

Rubber and plastic products

Other non-metallic mineral products

Basic metals  
Machinery and equipment  
Electrical and optical products  
Transport equipment  
Other

*N* is a nationality dummy: UK, US, EU and Japan owned firms;

*RI* is R&D intensity in the US subsidiaries with respect to parent R&D and is measured as the ratio of parent R&D expenditure to subsidiary turnover;

*SIZE* is the average size of firms and is measured in terms of turnover (or total sales);

*SIZED* is *SIZE* defined for UK domestically-owned firms;

*SIZEF* is *SIZE* defined for foreign owned firms;

*TFP* is total factor productivity and is measured as value-added per composite unit of labour and capital:  $TFP = V / [C^\beta L^{(1-\beta)}]$ , where *V* is value-added, *C* is the stock of capital, and *L* is employment. The coefficient  $\beta$  is the average share of capital income from 1992-1996.

*W* is average wages and is measured as the share of total remuneration to total number of employees in one firms.

*W<sub>uk</sub>* is *W* defined for UK domestically owned firms;

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# CHAPTER 1

## INTRODUCTION

### 1.1 Introduction

Foreign direct investment (FDI) has experienced a remarkable global growth over the last two decades. Between 1985 and 1995, the total global FDI stock almost quadrupled: from \$679 billion in 1985, it rose to \$2.7 trillion in 1995. In 1995, worldwide sales of foreign affiliates were over \$6 trillion, 30 percent higher than world exports (UNCTAD, 1997, p.4). Multinational enterprises (MNEs) have come to control a major share of the world's production and trade of goods and services. It is therefore not surprising that the role of FDI in the host country economy has received a tremendous amount of attention in both academic and political discussions.

In parallel with the above development, the theories of FDI and MNEs are now well established. Theories of multinational firms (Dunning, 1988a) address the ownership advantages of MNEs. It is generally agreed that the extent to which the MNE decides to establish foreign subsidiaries is influenced by the need to appropriate the rents accruing from investment in firm-specific knowledge-based assets and practices. On the other hand, while inward FDI has long been regarded by host country governments as a generator of jobs, the present crucial debate on the possible benefits from investment of foreign multinationals is also associated with the MNE as technology producer and disseminator. Technology is a key issue in the analysis of MNEs, because it constitutes one of the most important potential host country benefits of FDI. In fact, the driving force for host countries in attracting inward FDI is

increasingly linked to the role of MNEs in transmitting new ideas and technologies across national borders, particularly to industrialised economies and regional markets with locational advantages.

Technology transfer through MNEs consists of two stages. The first stage is internal transfer, i.e. from parent firm to foreign subsidiaries. The second stage is the transfer from foreign subsidiaries to host country local firms. As discussed in the literature (see for example Kokko, 1996), the main channel for the transfer of technology from foreign subsidiaries to host country local firms has been recognised as the so-called “spillover effects”, rather than formal technology transactions. With the term “spillover” or “external effects” or “involuntary technology diffusion”, economists describe the externalities associated with FDI. It refers to situations where the operations of foreign affiliates may lead to improvements in the technology or productivity of domestic firms. Spillovers occur since the affiliates are not able to extract the full value of the gains from for example knowledge-based assets. Positive spillover effects are supposed to be positively related to the extent to which the technology is transferred from the parent to the affiliate. In fact, spillover itself constitutes an important channel for technology transfer. The spillover effects are also a key concept in recent developments in growth theory, which have attributed great importance to externalities. Such theories maintain that long-term growth can be guaranteed through existence of technological spillover effects.

While there is a large stock of literature examining technology transfer and spillover benefits to developing host countries, very limited research of this kind has been done in situations where the host is a developed country. This thesis aims to



contribute to the understanding of technology transfer within a developed host country by empirically examining the impact of FDI on the UK economy, one that has long been the primary location for inward investment within Europe. Because productivity and the growth of productivity among domestic UK firms is highlighted as an important impact of FDI, production function approach is used in the empirical investigation. After reviewing the relevant literature, the study focuses on three important aspects of the transfer process:

- (1) the technology transfer process within the multinational firms (from parent to subsidiary) is investigated focusing on Scottish subsidiaries of US parents;
- (2) the productivity impact on host –country firms of intra-industry spillovers from FDI is examined using industry level UK data;
- (3) finally the productivity performance of foreign-owned and domestic firms is compared using a large UK firm-level data set.

The performance of the two types of firms above is assumed to be particularly associated with the “spillover hypothesis” (for domestic firms) and “intangible assets hypothesis” (for foreign-owned firms), both of which are the main focuses in the study. The performance of foreign subsidiaries is also assumed, according to the OLI paradigm (Dunning, 1980), to be associated with the country of origin of the subsidiaries.

It should be noted that three separate samples of data were used to investigate the aspects of the transfer process noted above. While one set would have been preferable, this was not possible due to data limitations. Information linking subsidiaries and parents and the gathering of data on US parents was particularly

difficult. Despite the three samples, most of the variables were taken from the FAME database, which is further described in the Appendix. To some extent the samples used reflect the particular methodology and estimating methods employed. Since a goal was to estimate results, which could be compared to other previous studies, this influenced the choice of sample somewhat.

The main aim of the dissertation is achieved by developing and testing the following hypotheses:

*Hypothesis 1: Multinational corporations transfer technologies from parent firms to their overseas subsidiaries, i.e. MNEs transfer technology internally. The extent of the transfer is related to the characteristics of both the subsidiaries and the parents, as well as the technology being transferred itself.*

*Hypothesis 2: The entry and operation of foreign MNEs generate spillover effects in the host country industries. The spillover effects are negatively related to technology gap between foreign and host country locally-owned firms and positively related to the technological capability of the local firms.*

*Hypothesis 3: Spillovers are bi-directional in situations where the host is a developed country. The existence of the bi-directional spillovers is related to the extent to which foreign and locally-owned firms compete against each other.*

*Hypothesis 4: Foreign subsidiaries enjoy higher economic performance than their host country counterparts. The performance difference can be attributed to both the differences in input proportions and spillover effects.*

*Hypothesis 5: The economic performance of foreign subsidiaries in the host country varies by nationality, i.e. there is a country-of-origin effect. This effect is related to the different advantages enjoyed by subsidiaries from different home countries.*

## **1.2 Background of the study**

This study is country-specific in that its focus is on the UK manufacturing sector. The choice of the UK is primarily motivated by the fact that the United Kingdom has for many years been the dominant European country in terms of acting as a host of MNEs, especially when compared with Germany and its other European competitors.

The importance of inward FDI in the UK economy can be seen from the following facts. Of the Financial Times top 500 companies operating in the UK, 313 are foreign owned, with Germany (87), France (77), Switzerland (28) and the Netherlands (17) being the most important European sources of MNEs. Just as UK multinationals dominate foreign direct investment in the United States, US multinationals account for the lion's share of foreign direct investment in the UK. Led by Nissan, Sony, Toyota and Honda, Japanese multinationals are also increasing their stake in the UK. The Confederation of British Industry (CBI) estimates that, by the

year 2010, subsidiaries of Japanese multinationals could produce as much as 20 per cent of the UK's industrial output (Griffiths and Wall,1995).

Unsurprisingly, Table 1.1 shows that foreign multinationals control a significant proportion of UK manufacturing output. Much of the foreign investment is concentrated in a relatively few industries: motor vehicles, office machinery, chemicals, rubber and plastics, instrument engineering, and mechanical engineering, etc. These are the industries most prone to internationalization. Overall, foreign MNEs currently account for approximately 20 percent of manufacturing output and the proportion is expected to continue to rise, largely due to the accelerating build-up by Japanese firms in the UK.

**Table 1.1**

**The Output Share of Foreign Multinationals in UK Manufacturing in 1995**

<b>Industries</b>	<b>Share of output (%)</b>
Motor vehicles	44.8
Office machine	36.6
Chemicals	32.8
Rubber and plastics	23.6
Instrument engineering	22.6
Mechanical engineering	20.1
Electrical engineering	17.2
Paper,printing and publishing	15.5
Food, alcohol and tobacco	14.8
Metal manufacture	13.4

Source: HMSO Census of Production.

With respect to the regional distribution of FDI, in the past Scotland, Wales and the North of England have taken advantage of the relatively large flows of USA manufacturing FDI to the UK. In each of these regions significant percentages of

manufacturing jobs were, and continue to be, dependent upon the stock of companies of USA origin.

The increasing presence of MNEs in the UK has attracted the attention of both academics and policy makers. There has emerged an extensive debate on the role that inward investment should play in the process of economic development and regeneration. At the national, regional and local levels, varying degrees of importance are attached to the position of inward investment in economic development policies and strategies.

There is a widespread feeling that the MNEs' role in the Britain economy is greater than the role played by MNEs in other comparatively developed Western economies such as Germany and Japan (Fine and Harris, 1985). Advocates of inward investment argue that one of the obvious benefits is that foreign subsidiaries bring with them new technologies and management techniques that may beneficially diffuse to the rest of the economy. For example, Nissan UK has followed the usual Japanese practice of cultivating close links with its suppliers, encouraging them to observe stringent new quality control standards. As a result, the quality of inputs to the UK car industry as a whole has improved. Similarly, Japanese companies have refused to recognize more than one union within their plants, offering domestic companies a new, alternative model for industrial relations.

Critics reject the notion that the activities of powerful, self-serving multinationals benefit the UK economy. Inward investment by MNEs raises different, but no less important concerns. For example, it is argued that incoming multinationals not only

escape paying their share of taxes, but also may drive local rivals out of the business, offsetting the expected employment gains.

The attitude of governments may be essential to any beneficial effects being realised. As is well known, many new theoretical models view the creation and exploitation of knowledge as the key factor driving the process of economic growth. This view is recognised in the latest government Competitiveness White Paper (DTI, 1998), which argues that FDI is one of the main transmission mechanisms behind the diffusion of knowledge across national borders. Earlier Competitive White Paper (Eltis and Higham, 1995; Eltis, 1996) highlighted the important role of inward investment in the transformation of the production process, helping to stimulate market competition and encouraging the transfer of innovative production and managerial techniques to UK owned companies. It is observed by the above authors that the growth of inward investment since the 1970s has coincided with a pick-up in the growth of labour productivity, particularly in the manufacturing sector, where output per employee hour rose by 4 per cent annum between 1981 and 1996, compared to growth averaging 2.8 per cent per annum between 1966 and 1981.

## **1.3 Data and methodology**

### **1.3.1 Data**

The firm-level data for foreign subsidiaries and UK-owned firms used in this study is mainly taken from the Financial Analysis Made Easy (FAME) database. FAME contains information on 270,000 major public and private British companies from the JordanWatch<sup>TM</sup> and JordanSurvey<sup>TM</sup> databases, and is one of the largest and most complete financial databases of British companies.

Up to five years of detailed financial information are given in the database. Further discussion of the FAME database can be found in the Data Appendix.

### 1.3.2 Methodology

This study uses several panel datasets, which are a combination of time series and cross-section data. Hsiao (1985, 1986), Klevmarken(1989) and Solon (1989) list several benefits from using panel data. These include the following:

(1) Controlling for individual heterogeneity. Panel data suggest that individuals, firms, states or countries are heterogeneous. Time series and cross-section studies run the risk of obtaining biased results when this heterogeneity is not accounted for.

(2) Panel data give more informative data, more variability, less collinearity among the variables, more degrees of freedom and greater efficiency. Time-series studies are plagued with multicollinearity

(3) Panel data are usually gathered on micro units, like individuals, firms and households. Many variables can be more accurately measured at the micro level, and biases resulting from aggregation over firms or individuals are eliminated (see Klemarken, 1989).

The use of panel data is not unproblematic, however, since the choice of an appropriate model depends *inter alia* on the degree of homogeneity of the intercept and slope coefficients and the extent to which any individual cross-section effects are correlated with the explanatory variables.

A panel data regression differs from a regular time-series or cross-section regression in that it has a double subscript on its variables, i.e.

$$y_{it} = \alpha + \beta' X_{it} + \varepsilon_{it} \quad i=1, \dots, N; \quad t=1, \dots, T \quad (1.1)$$

with  $i$  denoting households, individuals, firms, countries, etc., and  $t$  denoting time. The  $i$  subscript, therefore, denotes the cross-section dimension whereas  $t$  denotes the time-series dimension. With respect to (1.1) above,  $\alpha$  is a scalar,  $\beta$  is  $1 \times K$  and  $X_{it}$  is the  $it$ th observation on  $K$  explanatory variables. Most of the panel data applications utilize a one-way error component model for the disturbances, with

$$\varepsilon_{it} = u_i + v_{it} \quad (1.2)$$

Where  $u_i$  denotes the unobservable individual specific effect not included in the regression. The  $v_{it}$  denotes the remainder disturbances, and varies with individuals and time. It can be thought of as the usual disturbance in a regression.

One of the early uses of panel data in economics was in the context of estimating production function as in Hoch (1962) and Mundlak (1961), where allowance had to be made for unobservable effects specific to each production unit. This model is now referred to as the "fixed effects" (FE) model and is given by

$$y_{it} = \alpha_i + \beta' X_{it} + \varepsilon_{it} \quad i=1, \dots, N; \quad t=1, \dots, T \quad (1.3)$$



where  $y_{it}$  is the output and  $X_{it}$  the vector of inputs for the  $i$ th firm in the  $t$ th period;  $\alpha_i$  captures the firm specific unobserved inputs assumed to be constant over time, and  $\varepsilon_{it}$  is the error term satisfying the usual assumptions. The next important step was the dynamic model with "random effects" (RE) by Balestra and Berlove (1966) where  $\alpha_i$  in equation (1.3) are treated as random variable just like  $\varepsilon_{it}$ , and  $y_{i,t-1}$  is used as an explanatory variable. The random effects model has been further analysed by Wallace and Hussain (1969), Maddala (1971) and Nerlove (1971). Denoting  $\bar{y}_i = \frac{1}{T} \sum_t y_{it}$  and  $\bar{y} = \frac{1}{N} \sum_i \bar{y}_i$  we can decompose the total sum of squares  $T_{yy} = \sum_{i,t} (y_{it} - \bar{y})^2$  into two components as

$$T_{yy} = \sum_{i,t} (y_{it} - \bar{y})^2 = \sum_{i,t} (y_{it} - \bar{y}_i)^2 + \sum_{i,t} (\bar{y}_i - \bar{y})^2 = W_{yy} + B_{yy} \quad (1.4)$$

where:  $W_{yy}$  measures within group variation, and  $B_{yy}$  measures between group variation in  $y$ . Using similar decompositions for all the variances and covariances, we get the estimator  $\beta$  from (1.3) as  $\hat{\beta} = W_{xx}^{-1} W_{xy}$ . This is known as the "within group estimator". Assuming  $\alpha_i \simeq \text{IID}(0, \sigma_\alpha^2)$  and  $\varepsilon_{it} \simeq \text{IID}(0, \sigma^2)$ , we get the generalized least squares (GLS) estimator of  $\beta$  in the random effects model (Maddala, 1971):

$$\hat{\beta}_{GLS} = (W_{xx} + \theta B_{xx})^{-1} (W_{xy} + \theta B_{xy}) \quad (1.5)$$

where  $\theta = \frac{\sigma^2}{\sigma^2 + T\sigma_\alpha^2}$ .

Fuller and Battese (1973) show that this is the same as using the ordinary least square estimation with the pooled data (POLS):

$y_{it} - \lambda \bar{y}_i$  and  $X_{it} - \lambda \bar{X}_i$  where  $\lambda = 1 - \sqrt{\theta}$ .

These models differ mainly in their assumptions concerning the intercept  $u_i$  and error term  $v_{it}$  and can be used in different situations. The models are further discussed in chapter 3.

## 1.4 Structure of the study

This study is undertaken in a background where the UK is a major country hosting FDI. In addition, the UK government recognises the positive role of MNEs as a vehicle for transferring technology, which helps improve the performance of locally owned firms.

This introductory chapter has highlighted the importance of FDI and established the theoretical basis for the host country benefits from FDI. After outlining the structure of the study, the first chapter concludes with a summary of the significance of this study in comparison with other studies in the same area.

Chapter 2 reviews the relevant literature in the field, presenting the broad theoretical framework for the whole study. Since the context of the study involves the relationship between multinational investment and growth, the theoretical review begins by highlighting the role of technology and spillovers in new growth theory. Technology and related spillovers are in fact the theme of the current study. Further discussion emphasises the role of intangible assets, of which technology is the core, and also the role of human capital. As pointed out previously, it is the ownership of

intangible assets that motivate MNEs to invest overseas and makes countries willing to host FDI and benefit from it.

We subsequently review the literature on technology transfer, where attention is given to the mechanism involved in the determinants of the intra-firm transfer. Since the transfer of technology from foreign subsidiaries to host country local firms take place mainly through spillover effects, theoretical issues surrounding spillovers such as their identification, classification and their determinants are then discussed. The ownership of intangible assets, represented mainly by advanced technology, may make foreign owned firms outperform those of locally owned ones. Chapter 2 concludes with the presentation of various theoretical explanations of performance differences between foreign and domestically-owned firms.

The positive spillover effects from FDI can to a large extent only be guaranteed by making sure that intra-firm technology transfer occurs. Chapter 3 empirically examines whether such transfer occurs by reference to the case of Scotland, where US owned affiliates have for many years been the main foreign players. The impact of characteristics of both transferors and transferees on the transfer process is also investigated, as is the role of the technological capabilities of subsidiaries in enhancing the transfer process.

Spillover effects from FDI are empirically investigated in chapter 4 and chapter 5. Chapter 4 focuses on the impact of the presence of foreign owned firms on the productivity of UK locally-owned firms. The determinants of the impact of FDI are analysed using an industry-level panel data set. In contrast to chapter 4, where the

spillovers are typically treated as uni-directional, chapter 5 goes further by analysing spillover effects on the productivity growth of local firms in a situation where spillovers are deemed to be bi-directional, i.e. the spillovers come from the competitive interaction between foreign and locally owned firms.

Chapter 6 and chapter 7 explore the possible explanations for the superior performance of foreign owned firms over UK-owned firms. Chapter 6 makes use of factor proportion differences especially the differences in the levels of intangible assets and human capital to explain the productivity gap between foreign and locally owned firms. The impact of spillovers on the magnitude of the productivity gap is particularly stressed. Chapter 7 continues to focus on performance comparisons, but attention is placed on the country-of-origin effect, which means that the performance of foreign firms is associated with their nationality.

Chapter 8 concludes the study. The findings from the study are firstly summarized, followed by a discussion of policy implications. The dissertation ends by pointing out the limitations of the study and directions for further research on this topic.

## **1.5 Significance of the study**

The dissertation benefits from a number of studies in related areas including technology transfer, productivity spillovers and relative economic performance. These studies are largely nested in the multinational enterprises and FDI literature.

There is a rich stock of literature discussing technology transfer or spillovers by multinational enterprises, with most of the theoretical studies focusing on the

mechanism while the empirical studies focus on the determinants. In contrast, very few studies examine the extent to which the technology of parent firms is transferred to overseas affiliates. The part of the thesis on technology transfer largely follows Fors (1997) who studies Swedish MNEs. This study has extended the work of Fors in two aspects: first, while Fors separated the impact of parent and affiliate R&D on the productivity of the latter, here the complementary role of affiliate human capital in facilitating successful transfer of technology is highlighted; second, while Fors considers only the impact of the characteristics of both the technology itself and the affiliate on the transfer process, here the characteristics of the parent are also considered. This is also in contrast to other previous empirical work which typically models the technology transfer process as a function of the characteristics of either the host country as a whole, or host country firms. In addition, since technology transfer in this study is investigated by using Scottish data, where inward FDI has been particularly important, the study has obvious policy implications for economic development in regions with intensive foreign investment.

Our empirical examination of spillovers benefits from a number of previous studies especially the one of Kokko (1994), which is an extension of Caves (1974). The main contribution of this study is the augmentation of the traditional Caves-type model by adding the intangible assets of domestic firms as an explanatory variable to proxy their R&D stock or their accumulated investment in technology. A hypothesis is that the impact of foreign presence is greater when locally-owned firms have the technological capabilities to absorb the foreign technology. This section on spillovers also uses Kokko's distinction between spillovers from foreign presence and from competition. It is argued that while spillovers may be one way, e.g. from foreign

firms to local firms in a developing country, they should be bi-directional in developed countries, where the interaction between foreign and locally-owned firms is particularly relevant. The study should therefore contribute to the literature in a situation where the host is a developed country.

The section of the thesis focusing on the relative performance of foreign and locally owned firm largely follows Globerman, et al (1994) in methodology. However, this study is different from other current work in some aspects. First, we stress the special role played by intangible assets and human capital in making foreign owned firms outperform the locally owned ones, which is consistent with the conventional MNE theory. Second, we bring spillover effects into the picture contending that the existence of this phenomenon influences the magnitude of productivity gap between the two types of firms. Third, the country-of-origin effect on the performance of foreign owned firms is explicitly taken into account and quantified.

## **CHAPTER 2**

### **BROAD THEORETICAL FRAMEWORK: A SURVEY OF LITERATURE**

#### **2.1 Introduction**

Interest in the long-term comparative economic performance of nations has risen considerably in recent years. Traditionally the role of international trade in economic growth has been emphasized. Recent developments in new growth theories stress the potential of international transfer of technology and knowledge and the role of the related spillover effects through trade and foreign investments by MNEs to affect technical change and the economic growth of national economies (Grossman and Helpman, 1991; Romer, 1993). This is consistent with the spirit of recent FDI theory evolution, which stresses the spillover benefits to the host countries. In fact, new growth theory has incorporated the theory of MNEs. Both of theories stress the role of intangible assets, represented mainly by technology, and human capital.

For many years the popular discussion of inward investment and the focus of investment promotion agencies have tended to centre on the gross number of jobs believed to be created or safeguarded by such investments. Whilst this is of obvious importance for particular regions, for the economy as a whole it is arguably not the most appropriate way of assessing the benefits of inward investment. As intangible assets, represented mainly by technology, are the key element in MNE investment decisions, the long-term benefits for the host country must be associated with technological, and managerial improvements in locally owned firms.

A key question to ask here therefore, is whether the presence of intangible assets-intensive foreign subsidiaries has raised the level of technology of the host country firms and as a consequence, improved the productivity performance of these firms. In order for locally owned firms to benefit, it is important for the MNEs to transfer technology from the parent of the home country to the subsidiary of the host country. Once the technology is transferred to the subsidiary, local firms other than the subsidiary may benefit through external spillover effects. By doing so, the impact of the presence of foreign owned firms may become positively significant, since it can improve the performance of the host country local firms.

This chapter reviews the theoretical literature and lays the cornerstone for the following chapters.

## **2.2 Technology, spillovers and endogenous growth theory**

Until the late 1980s, economic theory on the relationship between growth and technological change was limited to a number of, mostly informal, frameworks outside the mainstream, such as Schumpeter's theory of 'basic innovations' and 'long waves' (Schumpeter, 1939, Freeman, Clark and Soete, 1982) and Nelson and Winter's 'evolutionary theory' (Nelson and Winter, 1982). Mainstream theory focused mainly on the Solow-Swan growth model (Solow, 1956, 1957, Swan, 1956) in which technological change is reduced to an exogenous time trend, although there were isolated contributions like Uzawa (1965), and Shell (1967) in which a more realistic representation of technology was provided.



During the late 1980s, with the contribution of Romer (1986), the idea of “endogenous technological change” entered the mainstream. Romer (1986) and Lucas (1988) provided models (partly similar to Arrow, 1962) that retain most of the neo-classical core ideas (rationally optimizing agents, perfect competition and the equilibrium concept), but endogenize technological change. In Lucas’ models, human capital formation (education, training, etc.) decisions influence the level of technology, Romer focused on the decisions concerning the direct search for technology through R&D investment.

Romer (1986) explicitly modelled R&D as a separate factor of production. The assumption of constant returns to scale with respect to the three factors, labour, physical capital and R&D enabled him to remain in the neo-classical premises of perfect competition. His most important innovation over Solow’s model is the introduction of knowledge spillovers into the model: knowledge (as a product of R&D) is assumed to have public good properties in the sense that the use of an “unit of knowledge” by one firm (say the firm that generated the knowledge) does not prevent other firms from using the same unit (knowledge is non-rival). Also no firms can be excluded from such use (knowledge is non-excludable). As a result, a positive difference between the social returns and private returns to R&D occurs and the economy as a whole faces increasing returns to scale.

Later on, growth theorists (e.g. Romer, 1990; Grossman and Helpman, 1991; Aghion and Howitt, 1992) formally introduced a solution to a problem directly related to the public good properties of knowledge generated by R&D. No firm would undertake any R&D if markets were perfectly competitive, because any other firm

would immediately imitate the process or product, achieving the same efficiency gain or quality improvement without incurring the R&D costs. Their “solution” to this deficiency consisted of models in which two sectors are distinguished: a conventional production sector and R&D sector. The R&D sector is assumed to have two kinds of output. First, general knowledge, which is non-appropriable and which spills over to other firms and second, blueprints for new products or new varieties of an existing product. The rents of these blueprints can be appropriated (by patenting or secrecy), so firms have an incentive to engage in R&D. But this introduces differentiated products into the analysis, and hence the market structure must be characterized as monopolistic competition rather than perfect competition. This leaves open the possibility of increasing returns to scale at the firm level, rather than only at the aggregate level.

Regarding technology spillovers, we will proceed from the distinction made by Griliches (1979) between rent spillovers and pure knowledge spillovers. Rent spillovers are solely caused by product innovations. Due to competitive pressures, the producer of the innovation is often unable to capture the “full price increase” that results from efficiency gains for customers, due to the higher quality of the innovation relative to the “old” product. For example, a new personal computer that can perform certain calculations twice as fast as the existing ones, will often be sold at a price between one and two times the price of the existing machines. As an immediate consequence, the price per efficiency unit has fallen, and the productivity of the firms using the new computer will rise.

In fact, as pointed out by Griliches (1992), rent spillovers are not true spillovers, because they are often caused by measurement errors connected to crude assumptions about, for example, homogeneous products. Moreover, one can not speak of a true externality even in the case of rent spillovers not caused by mismeasurement, because of the transaction-nature of the phenomenon.

Although the “later” new growth models, as well as some of the empirical implementations of these (such as Coe and Helpman, 1995), seem to be implicitly taking into account rent spillovers by the imperfect competition assumption, Griliches’ concept of pure knowledge spillovers is more central to the debate on endogenous growth, technology and increasing returns. In contrast to rent spillovers, knowledge spillovers are not embodied in traded goods, and thus do not occur in relation to market transactions. Pure spillovers are related to the partly public character of knowledge, and may occur when information is exchanged at conferences, when an R&D engineer moves from one firm to another, when a patent is disclosed, etc. Many more examples of sources for knowledge spillovers could be mentioned, but the most important common property is that relevant knowledge is transferred from one firm to another, without the receiver having to pay for it directly to the producer of the knowledge.

Although the spillover-receiving firm does not pay the knowledge-producing firm directly, the debate on knowledge spillovers has pointed out that spillovers cannot be assimilated without costs. For example, Cohen and Levinthal (1989) argue that a firm has to do some R&D itself to benefit from spillovers, thus arguing that

knowledge spillovers and the development of "own" knowledge are complements rather than substitutes.

### **2.3 The role of intangible assets and human capital**

It is generally agreed that economic growth and the boom of MNEs over the last decade has been closely connected to the increasing role of intangible assets (mainly technology) and human capital. To understand multinational enterprises and their impact on a host country, one has to focus on intangible assets and human capital, the key elements of modern MNEs.

While some economists were investigating the factors, which contribute to economic growth, others in a number of economic disciplines reshaped some of their major theoretical predictions. These changes can be characterised by the common inclusion of intangible factors of production in the new generation of models. In an attempt to motivate the more technical empirical analysis, this section summarises some supportive, albeit highly stylized examples of this claim.

Beginning with a well-known example from *growth theory*, the conventional Solow-Swan model was famous for its prediction of “conditional convergence”, whereby the steady state rate of growth varies across economies, depending on the savings rate, population growth and the shape of the production function. However, the assumptions of constant returns to scale and diminishing returns on each input also implied that per capita growth would eventually come to an end, if there were no exogenous improvements in technology. In contrast, according to Arrow’s (1962) model of “learning by doing” and other literature on endogenous growth (see. e.g.

Grossman and Helpman, 1991a; Aghion and Howitt, 1998), purposeful investment in intangible knowledge creation and spillovers to the rest of the economy through diffusion will lead to long-term growth even in developed countries.

Similarly, in the area of *industrial organization*, Sutton (1991) considers intangible investment in advertising and R&D as “endogenous sunk costs” – reflecting the irreversible nature of intangible investments in such areas as R&D or advertising. Within that framework, R&D and advertising are understood as being typically sunk investments intended to raise the consumers’ willingness to pay for the firm’s output. Broadening the traditional concept of the production function, these can be considered productive inputs to the output generation. The distinctive feature is that for the firm, R&D and advertising are strategic variables of choice. In contrast, the sunk costs involved in physical investments are determined exogenously by the underlying technology and consequently are equal across firms.

The role of intangible assets is especially highlighted in the *theory of multinational enterprises*. Locally bounded comparative cost advantages can only explain a (rather small) fraction of total transborder investment flows. The motivation for multinational investment is largely explained by the exploitation of firm-specific assets such as accumulated technological and organizational knowledge or reputation and the creation of brand (see e.g. Dunning, 1994; Caves, 1996). Again, it is precisely their intangible, non-commodity-like nature, which makes these assets difficult to trade and therefore largely specific to the firm. As a consequence, such assets are often exploited more effectively within the firm rather than through purely contractual exchanges across markets.

Human capital is stressed in the recent developments in growth theory. Although human capital is acquired through formal schooling, research and development, or even international trade, Lucas (1993) argues that on-the-job training is associated with rapid growth when the labour force moves quickly into more and more productive activities. This is the so-called “quality ladder”, described in Grossman and Helpman (1991, 1991a).

Apart from scattered case studies (see, e.g. Lucas, 1993), empirical evidence on the linkages between human capital formation, on-the-job training, and economic growth is limited. In this respect, micro-level evidence on multinational enterprises could be quite useful. Since foreign direct investment presumably represents a transfer of technology or ideas to the host country, it provides an opportunity to identify empirically the linkages between human capital formation, on-the-job training, and productivity growth. While the entry of MNEs provides the host country with access to knowledge, this access is enhanced if the foreign investors’ knowledge is absorbed by local workers. In fact, one important channel of technology transfer or spillovers is through, for example, labor mobility and the training of suppliers.

## **2.4 Technology transfer by MNEs**

Multinational enterprises (MNEs) are the major global producers and disseminators of technology. Since Hymer’s 1960 dissertation on the monopolistic advantages of the MNE (Hymer, 1976), a central issue in the theory of foreign direct investment (FDI) has been the nature of firm specific advantages and their transfer across borders. A principal belief is that the primary advantage that a firm brings to

foreign markets is its possession of superior knowledge. Largely, foreign direct investment is the transfer of an intermediate good, called knowledge, which embodies a firm's advantage, whether it is the knowledge underlying technology, production, marketing or other activities. It has been argued that some of the main host-country benefits of FDI are considered to stem from the inflows of new technology to affiliates of multinational enterprises, since these flows create a potential for technology spillovers to the host country's local firms ( Caves, 1974; Globerman, 1979; Mansfield and Romeo, 1980; Blomstrom, 1989; Kokko, 1994).

Past theoretical development on technology transfer has covered three general areas, describing how technology is transferred (markets vs hierarchies); the characteristics of the technology being transferred; and how organizational and technological attributes affect the success of technology transfer efforts.

A multinational which has specific advantage faces three options with regard to the extraction of rent from knowledge from foreign markets: FDI is regarded as the most important one, since exports may be limited by trade barriers. Licensing may be prone to market failure for a number of reasons, leaving explicit sales of technology to external agents as a less advantageous alternative.

One major explanation of the intra-firm transfer of technology is transaction cost theory, as originally developed by Coase (1937) and expanded by Williamson (1975) and others. The basic premise of this body of theory holds that intra-firm and market exchange mechanisms exhibit potentially different levels of efficiency in executing different types of transactions. The commonly held view is that MNEs

transfer technologies across borders to their foreign subsidiaries, rather than transact these technologies in the market.

Transaction cost theory argues that, because technology has the characteristics of a public good, it is difficult for the MNE to appropriate all the returns expected from its use. Public goods have two characteristics: jointness in consumption and nonexcludability. As a public good, knowledge is easy to transfer but hard to protect. The twin characteristics of jointness and nonexcludability imply that the private market cannot efficiently price knowledge. Transfer through the external market through mechanisms such as licensing will be difficult because of the high probability of free riding and opportunistic behaviour. Thus market or co-operative arrangements such as contracting upon intangible assets may raise the transaction costs related to the transfer. It can therefore be expected that firms internalize the market for intangible assets, rather than transacting them in the marketplace (Williamson, 1975). The public good quality of knowledge and the imperfections of the market therefore provide a rationale for the multinational's preference for wholly-owned subsidiaries as the vehicle for transferring technology to foreign affiliates.

The existence of an established affiliate itself in the receiving country is also hypothesized to influence the choice between internal and external mechanisms. The presence of an established affiliate implies that many of the fixed costs of internalization will have already been incurred. Even small, single-shot transfers may be conducted internally in such cases. It can be hypothesized that firms will exhibit greater use of internal transfer mechanism in countries where they have established affiliates.



However, it must be noted that, compared to market exchanges, there are significant fixed costs associated with organizing technology transactions on an intra-firm basis. Investments in legal, administrative and operating infrastructures must be incurred. In addition the parent will incur costs to monitor and control the performance of the firm formed or acquired to accept the transaction ( Alchian and Demsetz 1972; McManus 1975). As a consequence, it can be hypothesized that transactions involving peripheral technologies are less likely to be internalized than transactions in the parent's "mainstream" lines. Firms with high R&D expenditures are hypothesized to internalize transactions more frequently than firms with low R&D spending levels.

Kogut and Zander (1993) do not agree with the above explanation of technology transfer based on transaction costs and opportunism. In their view, firms are efficient means by which knowledge is created and transferred. In this very critical sense, what determines what a firm does, they argue, is not the failure of a market, but the firm's efficiency in this process of transformation relative to other firms. It is the difference in knowledge and the embedded capabilities between the creator and the users (possessed with complementary skills) which determine the firm's boundary, not market failure itself.

Cantwell (1989) developed the theory of technology accumulation. He argues that international intra-firm technology networks are developed due to the nature of technology itself, and not due to the character of markets for technology. Since technology is firm-specific due to a cumulative process and enriched by geographical

diversification, it is more valuable within the firm, especially a firm capable of expanding its network, than to a firm with a separate and differentiated technological pattern. Technology generation and utilization are linked within the firm.

The effect of the characteristics of technology on its transfer has been discussed in a large stream of literature addressing the adoption and diffusion of innovations. Examples of attributes of innovation that have been studied, to determine their influence on the transfer process, include innovation cost (Ettlie and Vallenga, 1979), innovation complexity, relative advantage, trialability and observability (Pelz, 1985; Rogers, 1983), reliability, scientific status, importance, communicability, and flexibility (Tornatzky and Klein, 1982). These innovation attributes studies generally report relationships such as this: the higher an innovation's complexity, the lower its likelihood of adoption due to the higher transfer costs involved. (Tornatzky and Klein, 1982). As the complexity of the technology increases, more integrated structures or relationships with other organizations are required (Allen et al, 1979; Kazanjian and Drazin, 1986; Killing, 1980).

There is a dilemma that firms involved in a technology transfer agreement with another party must confront. On the one hand, the greater the difference there is between the firms' knowledge architectures, the more the one firm can potentially learn from the other. On the other hand, the greater the difference there is between the firms' knowledge architectures, the more effort that will be required to learn from a partner through knowledge and technology transfer. A firm must choose between the potential for learning and the likelihood of learning from a collaborative agreement.

Some firms, however, apparently have the ability to learn and adapt more rapidly to the use of new technologies or knowledge than others (Teece et al, 1992).

There are also studies that examine the influence of organizational attributes on the import of new technologies. These organizational attributes include size, centralization, formalization (Ettlie et al., 1984), organizational complexity (Pelz, 1985), centralization of decision-making, exposure to external information and managerial attitudes (Carter and Williams, 1959; Dewar and Dutton, 1986). These studies suggest that organizational characteristics such as centralization, formalization, and complexity must correspond to the characteristics (complexity, radicalness, etc.) of the new technology for transfer to be successful (Burns and Stalker, 1966; Lawrence and Lorsch, 1967; Ettlie et al., 1984; Dewar and Dutton, 1986).

The receiving organization's adaptive ability has been particularly emphasized in recent literature. Organizational adaptive ability includes staff flexibility and production flexibility (Rebentisch and Ferretti, 1995). Staff flexibility relates to an organization's ability to use its employees to bridge the gap between its existing knowledge architecture and that demanded by a new technology. Production flexibility is a gauge of the relative availability of production line resources that can be used to respond to non-routine events such as problem-solving, equipment modifications, or product trial runs. The effect of the organization's adaptive ability on a transfer depends on how an organization's adaptive ability applies specifically to that case of technology transfer.

In fact, both the characteristics of a technology and organizational attributes are associated with the considerable costs related to the transfer of technology, which has been the focus of recent literature on innovation. Teece (1977) defined the cost of transfer to include both transmission and absorption costs. He concluded that the resources required to transfer technology internationally are considerable and therefore it is quite inappropriate to regard existing technology as something that can be made available to all at zero social cost. Cantwell (1991), Kogut and Zander (1993) and Eden et al (1997) discussed the costs relating to provision of technology to other firms. In Eden et al (1997), for public technology, these provision costs are approximately zero; whereas for tacit knowledge, provision costs can be substantial, although they may fall if the transfer of technology is repeated.

Directing attention away from transfer costs, the more recent literature brings the competitiveness of host country firms into the picture. Wang and Blomstrom (1992) treat the MNE affiliates' technology imports as strategic variables in the interaction between MNE affiliates and host country firms. More specifically, they argue that the MNE's profit is a function of the size of the technology gap between the affiliate and local firms. The role of competition from the host country firm is highlighted as an important determinant of the rate at which MNE affiliates import technology. Increased competitiveness in local firms means that technology gap between local firms and foreign affiliates becomes narrower, which reduces the demand for affiliates' products and gives them a reason to bring in new technology in order to restore their advantages.

## 2.5 MNEs' investment and Spillovers

It might be argued that technology transfer to affiliates only leads to a geographical diffusion of technology, but not to transfers to new users, because the ownership and control of technologies are largely kept in the MNEs possession. However, it has been suggested that significant transfers of technology to local host country firms come from external effects or spillovers, rather than formal transactions (Blomstrom, 1989). In fact, some of the main host country benefits of FDI are considered to stem from the inflows of new technology to affiliates of MNEs, since these flows create a potential for technology spillovers to the host country local firms (Caves, 1974; Globerman, 1979; Blomstrom, 1989; Kokko, 1994). The technology and productivity of local firms may improve as a result of the existence of spillovers. Thus the term “spillover” has a broader meaning than “imitation” or even “technology diffusion” (although technology is at the center of the concept) and it should perhaps primarily be associated with productivity - hence the use of the interchangeable terms *productivity spillover* and *technology spillover*.

An early contribution to the theoretical literature on spillovers was supplied by Caves (1971, 1974) who identified various external effects when examining the general welfare impact of FDI. Caves (1974, p. 176) noted that productivity spillovers occur when the multinational firm ‘cannot capture all quasi-rents due to its productive activities, or to the removal of distortions by the subsidiary’s competitive pressure.’ He divided the external benefits into three categories. First, multinational firms may raise productivity levels among domestic firms in the industries, which they enter by improving the allocation of resources in those industries. Given that FDI tends to occur in industries with high entry barriers, these competitive effects reduce

monopolistic distortions and their associated inefficiencies. Second, through either the multinational's competitive force or demonstration effect, domestic firms operating in imperfect markets may be induced to a higher level of technical or X-efficiency. Finally, the presence of multinational subsidiaries in an industry may speed the process or lower the cost of the transfer of technology. The threat of competition may spur firms, which might otherwise have been laggards to adopt best practice technology sooner. Imitation effects and the movement of personnel trained by multinational subsidiaries also enhance the transfer of technology to home-owned firms.

Following Caves (1971, 1974), Kokko (1992) distinguishes between effects on local productivity and technology that are primarily results of demonstration, imitation, and contagion and effects that are mainly caused by competition (although these are also likely to coincide). He argues that demonstration and contagion effects occur because of differences in technology and information between MNE affiliates and local firms, whereas competition depends on market characteristics and interactions between foreign and local firms. Another difference, he argues, is that contagion is related to the extent of foreign presence, whereas competition may have less to do with market shares. Kokko contends that the strongest competitive challenge to local firms may well come from foreign affiliates that have recently entered the host country and still operate at a small scale, but are trying to capture a larger share of the market. Recently, Eden *et al* (1997) summarize the ways that MNE technology can spill over to host country firms as following: (1) the demonstration effect; (2) learning--by-doing; (3) training of local employees by the MNE; (4) competition effects between foreign and local firms.

Theoretical models in this area have been focusing on the determinants of spillovers. In Findlay (1978) and Koizumi and Kopecky (1977), spillovers are made possible by differences in the technological levels of local firms and MNEs. Their size or extent is determined by the size of the technology gap or the foreign share of assets or employment in the industry. A formal representation of the relationship between the technology gap and spillovers effects, for example, involves two very different perspectives. On the one hand, it is argued, according to the “advantages of backwardness hypothesis”, that the wider the disparities, the greater the opportunities for indigenous firms to achieve higher levels of efficiency by imitating foreign technologies (Findlay, 1978). On the other hand, it is asserted that a wide technology gap impairs indigenous firms' ability to catch up with foreign competitors (Cantwell, 1989, 1993).

The more recent models have progressed towards making spillovers endogenous, and have also included the level of competition among the determinants. In Das's theoretical model (Das, 1987), spillovers leads to costs for the MNE affiliates, since the benefits gained by local firms sooner or later translate into increasing competition. He demonstrates that the existence of spillovers will influence the behavior of the multinational corporation. In particular he found that the price determined by the subsidiary in the foreign market is higher than in the absence of learning on the part of the native firms. As a result of this, the competition of local firms will increase at a slower rate than if prices had remained unchanged. However, the behavior of local firms is not taken into account explicitly in his model.

The role of the potential effects from the strategic interaction between foreign and local firms has been brought into the picture in the more recent spillovers literature. Assuming that local firms are also aware of spillovers, Wang and Blomstrom (1992) extended the work of Das (1987). Putting both foreign and local firms in a differential game, they treat spillovers as an endogenous phenomenon resulting from the strategic interaction between MNE affiliates and local firms. The most interesting conclusion of the model is that the total amount of spillovers of MNE technology is not exogenously fixed (although some spillovers may occur automatically). Instead, both the MNE affiliate and the local firm are able to influence the extent of spillovers through their investment decision.

In summary, taking into account the above interesting lines of development in the recent literature, it can be concluded that existence and the amount of technological spillovers may depend on a heterogeneous set of conditions. A reasonable way forward therefore, according to Perez (1997), is to assume the relationship discussed above is a non-linear one. Spillovers may increase with the technological gap up to a certain critical level. Beyond this point, technological competence by indigenous firms will be so low that they will generally not be able to exploit fully the technological opportunities arising from foreign MNE presence. Thus, as technological disparities increase further, spillovers diminish as does the ability of domestic firms to catch up with foreign competitors. In fact, the interaction between foreign and indigenous firms at the technological level may generate two different outcomes: one corresponding to a virtuous circle of technological development and the other to a process of cumulative decline in the domestic industry.



## **2.6 Relative performance of MNEs**

According to the structure-conduct-performance (SCP) paradigm in industrial economics, structural conditions determine the conduct or behaviour and subsequent performance of a firm (Bain, 1959). This assumption has certain limitations as it understates the role of firm-specific competencies. In light of this limitation, efficiency theory in industrial economics contends that an industry's structural imperfections arise largely as a result of superior operating efficiency by particular firms. Increased profits are assumed to accrue to more efficient firms because they possess efficiency-generating competence and not because of collusive activities (McGee, 1988). Thus, as Porter (1986) states, firm performance can be decomposed into an effect from industry structural characteristics and an effect from firm competence.

When the industry structure of a host country is imperfect, FDI will flow in as a direct response. Foreign owned firms in oligopolistic industries enjoy market benefits of entry barriers erected to new entrants and enjoy other characteristics that give them market power; they have sufficient market power so that they can overcome the disadvantages of being foreign and competing with local competitors in host countries where they have facilities (Brewer, 1993).

Resource-based theory suggests that a firm's performance depends on its distinctive resources or competence (Porter, 1986). This competence appears to be crucial when a firm enters a foreign market through FDI because the business and political risks facing the firm in the host setting are fundamentally greater than in the

domestic context (Brewer, 1993). When a host environment seems complex, dynamic and uncertain, the superior competence that the foreign owned firm is equipped with becomes even more critical and imperative for the host success.

The competence of foreign owned firms is mainly represented by intangible assets or advanced technology. Standard multinational theory claims that MNEs bring with them some amount of proprietary technology that constitute their firm-specific advantages, which allows them to compete successfully with local firms who have the superior knowledge of local markets, consumer preferences, and business practices.

Multinational expansion is thought to bring significant performance benefits to organizations because of a variety of reasons. According to Kapler (1997), there are: (1) the internationalization of cross-border transactions that are more costly if carried at arm's length; (2) market power deriving from operations within industries with high barriers to entry; (3) international sourcing of location-specific R&D initiatives or progress, and "technological accumulation" via innovative feedback effects from adapting technology in varying geographical environments (Cantwell, 1989); (4) geographical diversification which may increase supply and production flexibility and counter the effects of national business cycles and changes in exchange rates and national terms of trade (Caves, 1982); and (5) the superior capabilities enjoyed by "core" firms in a dual economy to pursue competitive intra-firm capital flows to achieve diversification into highly profitable and fast-growing industry subsectors, both in the home country and abroad. The above arguments suggest that higher productivity in foreign owned firms may not always reflect superior technology, but

rather market power or other characteristics that do not make up a base for contagion-related spillovers.

Another explanation of the superior performance of foreign MNEs comes from “best practice” theory. Foreign firms may indeed be bringing in best practice from overseas. This would seem to be the dominant explanation for the distinctive performance of Japanese manufacturing sites in Europe. Other studies have indicated that Japanese firms have a distinctive set of manufacturing practices which have been characterized as lean production ( see CBI, 1993 and Wookmack, 1990). One would expect Japanese firms to bring these practices with them, resulting in superior ratings for both practice and performance.

Foreign parents may concentrate in industries such as vehicle manufacturing where world-class practices are prevalent, whereas domestic sites also include many industries, which are either protected from or do not face international competition due to other factors. There is evidence from studies of Japanese overseas expansion ( see, e.g. Carr, 1992 and Mayes and Ogiwara, 1992) which suggests that this is true: Japanese overseas sites are heavily concentrated in consumer electronics, other electronics and vehicle manufacturing.

The USA and Japan are commonly cited as leading the rest of the world in manufacturing practices and performance, and many business practices associated with world-class manufacturing were initiated in either Japan or the USA. Foreign ownership may provide a “platform” for the diffusion of the “best practices” in manufacturing to sites in other countries. In particular, much interest has been paid

recently to the role of Japanese plants operating overseas in diffusing manufacturing practices associated with world-class performance; for example, Japanese companies, which have located in motor vehicle and electronics production in the UK have been successful in their endeavors.

Abo (1994) studied Japanese manufacturing sites in the USA and argued that the actual practices in these plants are a hybrid between the Japanese and US patterns of manufacture. He coined the term “Hybrid Factory” for such sites. This explanation may also be applicable to sites with other parents. North American and other foreign owners may bring their own new and distinctive practices that may result in improved practice and performance relative to domestic firms.

There are different mechanisms by which the coming and presence of superior MNEs can affect the productivity of host country firms. Increases in productivity in the location where the foreign firms invest and the industry as a whole as a result of foreign ownership may occur for a number of reasons. The average level of productivity in an industry may rise because of *composition* effects where higher productivity foreign firms replace lower productivity domestic firms. The theoretical reasons explaining why multinational firms exist show that in order for the foreign firm to want to enter the domestic market it must expect a higher return than domestic firms (since costs are presumed cheaper for domestic firms). These higher returns may be because the foreign-owned firm is more productive. *Demonstration* effects mean that domestic firms may be able to imitate the technology and practices used by foreign firms. This would affect both the average industry level of productivity and also the level of productivity in individual domestic-owned establishments. Similarly,

foreign firms may introduce *competition* into a previously relatively uncompetitive domestic product market, and they broaden the market size by opening up access to foreign markets. Foreign firms may hire and train workers who then either earn higher wages or go to work for other (domestic) firms who then benefit through higher labour productivity. They may also open up access to higher quality capital inputs, e.g. through access to foreign factor markets.

## 2.7 Summary

This chapter has reviewed the literature on multinationals regarding technology transfer and its indirect impact on locally owned firms in host countries. The role of intangible assets or technology and spillovers are major themes on the research agenda on contemporary multinationals. The MNE arises due to its deployment of intangible assets across borders; technology transfer has been the goal of both multinationals and host country governments, with spillovers being widely regarded as the main channel. While ownership of advanced technology may make MNE subsidiaries outperform host country firms, the technology transfer and spillovers may improve the performance of the local firms as well.

Setting in a broader theoretical background, section 2.2 discusses the evolution of endogenous growth theory in relation to technology and spillovers. Romer (1986) believes that increasing returns to scale and therefore economic growth can be guaranteed due to the nature of endogeneity of technology, which is treated as a separate variable in his production function, and the existence of knowledge spillovers. The treatment of spillovers in the new growth theory is consistent with the conventional theory of foreign direct investment. In the latter theory, the host country

can improve the productivity by capturing spillover effects induced by the presence of foreign subsidiaries.

Section 2.3 further discusses the role of technology by highlighting the treatment of intangible assets and human capital in different domains of economics. In the new growth theory, investment in intangible assets is a critical factor for maintaining long-term economic growth. In the theory of industrial organization, intangible investment is treated as endogenous sunk costs. Therefore advertising and R&D are considered productive inputs to the output generation. Still in the theory of multinational enterprises, it is the efficient exploitation of firm-specific intangible assets that motivate their transnational investment. Relying on new growth theory again, the incorporation of human capital into the theory is based on the idea that the movement of high quality labour may generate spillover effects. In relation to technology transfer, the human capital of the host country firms is related to their absorptive capability.

The literature review in sections 2.4-2.6 is much more closely linked to the empirical part of this thesis. Section 2.4 reviews those theories that explain why MNEs transfer technologies and the determinants of such transfer. We first contrast conventional transaction cost theory with those developed by Kogut and Zander (1993), which argues that the transfer of technology within a MNE arises not out of the failure of markets for the buying and selling of knowledge, but out of its superior efficiency as an organizational vehicle by which to transfer this knowledge across borders. We then discuss the determinants of technology transfer arguing that the transfer costs involved are the important factor affecting the transfer process. The

transfer costs relate to both the attributes of the organizations involved and the characteristics of the technology being transferred itself.

Section 2.5 focuses on the literature on spillover effects associated with the MNEs' investment. Spillovers are considered to be the most important channel of technology transfer from multinational subsidiaries to host country local firms, and constitute the main host country benefits of FDI. Spillovers can arise due to demonstration effects, learning-by-doing, employee movement from the MNE to local firms, and competition effects between foreign and local firms. In particular this section introduces Kokko's distinction between spillovers from demonstration and contagion and spillovers from competition. Thus, with respect to the determinants of spillovers, we conclude that spillover effects are mainly influenced by the share of foreign presence, the technology gap between foreign and local firms and the degree of competition between the two types of firms in particular in recent literature.

From the perspective of the multinational theory, the ownership advantage should make MNEs outperform their host country counterparts. The last section of this chapter offers various explanations for the superior performance of MNEs. These theories include resource-based theory, multinational theory, and "best practice theory". Considering host country local firms, their economic performance could be improved due to the spillover effects brought by the superior-performed foreign subsidiaries.

## CHAPTER 3

### TECHNOLOGY TRANSFER FROM AMERICAN PARENT FIRMS TO SUBSIDIARIES IN SCOTLAND

#### 3.1 Introduction

Multinational enterprises (MNEs) have become important economic agents with respect to the generation, commercialisation and international transfer of technology. Dunning (1993, p.290) estimates that between 75 and 80 percent of all private world-wide R&D expenditure, the basic input into the technology generation process, is accounted for by MNEs. The importance of this knowledge generation role is enhanced given that technology is recognised as a key determinant of economic growth and international competitiveness.

The technology generated by the MNE can be used in its home plant and/or its subsidiaries abroad. In order to ensure appropriability of the returns to their R&D investment, MNEs have an incentive to exploit their technologies within the boundaries of their own organisation rather than across markets. The transfer of knowledge within the MNE from parent firms to their foreign affiliates may be seen as an attempt to take advantage of economies of scale from “know-how” in multiple plants abroad and also to minimise the transactions costs associated with using external markets.

Using a firm-level panel data set, this chapter aims to estimate the extent to which technology generated by US multinational manufacturing firms is transferred to their affiliates in Scotland. In our study, technology transfer within the MNE is



considered to be the measured impact of R&D expenditure by the parent firm on the productivity of the Scottish subsidiary. Unlike previous papers (for example Fors, 1997), the transfer of technology is not assumed to be without cost. In fact the effect of various characteristics of the subsidiaries and parents on the transfer process is emphasised. Also, the subsidiaries' own human capital stock is included as an independent variable to capture the effects of less formal innovation i.e. learning by doing.

The rest of this chapter is organised as follows. The next section sets out the rationale for investigating technology transfer on a regional basis by discussing the role of foreign subsidiaries in regional economic development. Section 3.3 reviews the literature on R&D and productivity, to which the methodology of this chapter relates. Section 3.4 reviews the previous theoretical and empirical work in the area. Section 3.5 describes the data, model and estimation techniques, while results are reported in section 3.6. Finally, section 3.7 concludes the chapter.

## **3.2 Foreign subsidiaries and regional economic development**

The impact of FDI in terms of costs and benefits for the host economy has long been recognised in the FDI literature. Broadly speaking, FDI is likely to increase international integration and interdependence by facilitating the trade of goods, services and knowledge. It allows countries to specialise more effectively and, to increase the benefits of comparative advantage based on trade and economies of scale. In this way, FDI should increase productivity, produce widespread competitive effects and generally promote growth effects within the host economy. In addition, this

should be accompanied by spillovers into the domestic economy, which one would not associate with gains from trade.

A considerable literature has emerged on the theme of regional economic development<sup>1</sup>. For a long period the focus of attention has been around the issues of the development of new industries, the creation of clusters and the development of linkages in order to obtain self-sustaining regional growth. In recent years, the discussion of linkages has been associated with the role of MNE subsidiaries as technological leaders and technology disseminators in the process of regional development.

While it is recognised that the regional benefits derived from FDI depend to a large degree on the extent of integration between foreign investors and local firms in terms of linkages, great emphasis in the literature is given to the “quality” and dynamic nature of linkages, together with the longer-term implications for local economic development. Turok (1993) identified two distinctive scenarios – “developmental” and “dependent” to describe the possible results of subsidiary related local linkages. In the developmental scenario, economic pressure exerted by the foreign subsidiaries is alleged to promote more collaborative relationships between individual plants, suppliers and distributors within the value chain and therefore new “specialist suppliers”. The emphasis in this perspective is clearly on the potential of inward investment to induce all-round development. In the “dependent” scenario, local firms are weak nodes within a wider network of powerful multinationals. The

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<sup>1</sup> Studies include those which deal with the effect of economic integration on regional development such as Clark, Wilson and Bradley (1969) or, more recently, Molle and Boeckhout (1995); those macroeconomic growth rates within subnational regions as Barro and Sala-I-Martin (1992); and those which deal with the concept of industrial districts such as Harrison (1992).

direct global connections expose local economies to volatile world markets and make them vulnerable to forces of international competition. Moreover, the motives for MNEs extending local linkages are driven more by cost-cutting than by a desire to add value through the exchange of technology and information. Linkages with suppliers are hierarchical and the relationships adverse rather than co-operative. Such linkages could promote economic and technical dependence.

In discussing linkages, one has to mention the literature on the development of a suitable typology for MNE subsidiaries. Much of this (e.g. Porter, 1986; Bartlett and Ghoshal, 1986;) originates from the corporate strategy literature and, thus, concentrates on the strategic aspects of the affiliate's behaviour. The recurring theme of this stream of analysis is to define the MNE affiliate with an emphasis on its contribution to the value-added chain<sup>2</sup>. This concept is useful, since the number of activities in the value-added chain, which the subsidiary undertakes will have an influence upon regional economic development. However, the impact of the technology element of the value-added chain is often ignored in the literature.

The most important linkage must be associated with the technological connection between foreign subsidiaries and local firms. It is widely believed that the most important benefits from the existence of foreign subsidiaries is that they may bring advanced technologies to the host country firms and generate spillover effects. Regarding technology transfer from parent to subsidiary, it is claimed that the subsidiary itself may not be the only beneficiary from the technology transfer. Policy makers are aware that the technological competence of firms located within a region

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<sup>2</sup> Dunning's term value-added chain is used in preference to Porter's value chain, since it is felt that it more accurately describes the activity of adding key functions to the production process.

influences both their unit costs and product quality and hence their growth potential. In this respect the multinational subsidiary is assigned a pivotal role in the development process as the “technological receiver” of foreign know-how. As Das (1987) points out, multinationals transfer new technology from the parent headquarters to their overseas subsidiaries and the host country firms then learn from these subsidiaries. The first domestic learner or partner might be a “national champion”. Once it has mastered the technology, the champion diffuses it to other firms. The diffusion may take place through social networking, factory visits, collaborative research, movement of personnel and forward and backward linkages (Buckley and Casson, 1998).

According to Perez (1997), the extent of linkages between foreign and locally owned firms influences the size and frequency of technological spillovers to local firms, and is likely to be positively related with the level of technological development of the indigenous firms. A low level of technological competence will render indigenous firms unable to meet the technological standards required by foreign firms and, hence, will reduce local sourcing by foreign enterprises with perverse effects on technological spillovers.

Recently, the dynamic benefits from FDI for countries and regions has been emphasised. Similar to Turok (1993), Young, Hood and Peters (1994) use the term “developmental subsidiaries” to describe those which provide dynamic benefits for the host economy in terms of demonstration effects among suppliers, customers, and competitors. Other dynamic benefits include technological spin-offs and new firm

creation. The above authors credit the emergence of “developmental” subsidiaries to the internal capabilities of the affiliates and innovation-oriented local management.

The above dynamic benefits are associated with a “virtuous cycle” of interaction between foreign subsidiaries and local firms. While Ozawa (1992) has presented “a dynamic paradigm of FDI-facilitated development”, the concepts of virtuous and vicious cycles of technological development are linked to Pavitt (1987) and Cantwell (1989, 1993). They are also constituents of what Dunning (1993) refers to the asset accumulation and restructuring paradigm emphasising the role of accumulation and diffusion of technology in promoting formation of a “virtuous cycle”. The above authors argue that MNEs may play a part in a “virtuous cycle” of increasing technological capability of host country firms. By a process of cumulative causation, countries can grow rapidly, and then are able to devote resources to encourage indigenous technological development. This will further attract inward investment in research intensive activities and R&D; the activities of the latter, in turn, stimulate local rivals to a higher rate of innovation and encourage agglomerative economies in technological centres of excellence in host economies.

A “virtuous cycle of development” could be enhanced again if the indigenous firms are themselves capable of assisting multinational firms in a partnership arrangement. In return local sourcing might be increased. For example, they may be able to provide expertise from their own development and production engineers; or to provide knowledge about markets and competitors that stem from operating internationally. Local firms will be appreciated if they can provide intelligent

resources to assist in problem-solving, and help identify ways of increasing quality and cutting waste in multinational firms.

In contrast, a “vicious cycle” is also a possibility, in which declining technological capability may occur in weaker host country sectors. As Young, Hood and Peters (1994) explain, for example, when FDI takes the form of assembly activities. Here the greater efficiency of the foreign firm can lead to lower sales and profits for indigenous firms and a decline in technological expertise. For example, Turok (1993) argues that with respect to inward investment in the Scottish electronics industry, the dynamic benefits have been limited. Focusing on the level of local sourcing, Turok finds that foreign firms were far more likely to import components and have weak local linkages than UK companies, since "technology is an important barrier to increased sourcing from indigenous firms".

Empirical studies examining the regional benefits of manufacturing FDI have been cautiously positive. For example, Peck (1990), in a study on North East England, demonstrates that technology is transferred to local firms, and inward investment therefore stimulates further investment, both domestic and foreign. Morris et al (1993) demonstrates how Japanese investment has been connected to the take-up of new industrial relations and work organization practices, and the development of subconstructing manufacturing complexes in Wales. Hill & Keegan (1993) show that the growth of foreign manufacturing in Wales has been connected to improvements in overall manufacturing productivity and a falling trend in unit labour costs. However, other studies on the impact of FDI on UK regions find that, while foreign subsidiaries have had a positive effect, the spillover effects, particularly with regard to local

sourcing, have been extremely disappointing. Moreover, Ashcroft and Love (1993) argue that as well as the disappointing spillover effects, there is evidence to suggest that the truncated nature of MNE activities within the peripheral regions can lead to a restriction of supply potential in the long run.

Given that Scotland has been an important regional host for multinational investment for some time, the impact of FDI on the wider economy is an important issue. In fact there have been various studies on the impact of MNEs on the Scottish economy (e.g. Young et al, 1988, Young, et al, 1994, Taggart, 1996), and on R&D in affiliates of MNEs in Scotland (Haug et al, 1983, Taggart, 1998). However no econometric investigation has been carried out on technology transfer within MNEs operating in Scotland. An examination of US-based multinationals seems particularly warranted given their prominence in the Scottish economy and given the major role of US firms in generating new technology<sup>3</sup>.

### **3.3 R&D and productivity**

As stated previously, technology transfer within the MNE in this chapter is considered to be the measured impact of R&D expenditure by the parent firm on the productivity of the Scottish subsidiary. The methodological part of the study is closely associated with the relationship between R&D and productivity.

Since Solow's (1957) decomposition of economic growth, much research by economists has focused on the factors which underly the productivity residual, one of

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<sup>3</sup> Overseas Companies Operating in Scotland 1995/96 directory published by Scottish Enterprise (1997) shows that out of 578 overseas companies operating in Scotland, 268 are US based. The US is the largest source of Scottish inward investment, especially in manufacturing sector.

the major factors enhancing productivity growth. This concern has led to the development of models of endogenous growth and to the inclusion of other factors that could explain this residual in both theoretical and empirical analysis. Investment in R&D has been one of these factors and the analysis of the relationship between R&D and productivity has played a major role in the economic growth literature (Griliches, 1979 and 1988; Grossman and Helpman, 1991; Coe and Helpman, 1995).

One of the main objectives of the economic analysis of the R&D-productivity relationship is to evaluate whether the returns to this investment justify the initial expenditure. Such an analysis proves to be particularly difficult for a number of reasons, but most frequently it is due to the poor data available for the empirical investigation. Another issue concerns the measurement of the R&D capital. R&D capital represents the stock of knowledge a firm or an industry possesses at a certain point in time, and it is combined with other inputs to produce outputs. As Griliches (1979) points out, there are three major problems to consider:

- (1) the effect of R&D on output growth can only be visible after a certain period of time;
- (2) R&D depreciates over time and an evaluation of this depreciation process is needed;
- (3) There are important spillover effects within R&D activities.

The first two issues have been addressed by constructing a series for R&D capital stock using a perpetual inventory model with declining balance depreciation (Griliches and Mairesse, 1983 and Mairesse and Hall, 1996). This involves calculating R&D capital stock by the weighted sum of past R&D expenditures using a



constant rate of obsolescence percentage per year. As for the third point, attempts have been made to evaluate spillover effects both at the aggregate and at the industry level (Mairesse and Sassenou, 1991; Coe and Helpman, 1995; Lichtenberg and Van Pottelsberghe de la Potterie, 1996). Even when spillover effects are not the direct object of the analysis, as it is the case in this chapter, they do impact on the extent to which the subsidiary appropriates returns from using the parent's R&D.

Despite the above problems in dealing with the precise relationship between R&D and productivity, a large number of studies have attempted to evaluate this relationship. The analysis has been undertaken at different levels of aggregation: from the analysis of a particular sector (agriculture - see, Griliches 1956), to the whole economy (Coe and Helpman, 1995), from the industry level (Griliches and Mairesse, 1984), to the firm level (Griliches, 1979 and 1984; Mairesse and Hall, 1996). In this present work our interest is at the firm level, although our concern is the effect of parent R&D on its overseas subsidiary's productivity.

Most studies at the firm level concentrated on the parent firm's R&D on its own productivity. Despite the different data sets used across different time periods, R&D is invariably found to have a significant and positive effect on output growth, after taking account of the influence of other inputs. But the range of estimates of the elasticity of output with respect to R&D does vary by study (for a survey, see Mairesse and Sassenou, 1991).

Recent theoretical models of endogenous growth emphasize that the R&D expenditures of individual firms contribute to sustained long-run growth of an

economy through their industry-wide spillover effect (Grossman and Helpman, 1991; Grossman and Helpman, 1991a; Romer, 1986). According to this view, individual firms invest in R&D to acquire private knowledge that enhances their productivity and profit. Private knowledge of individual firms then spills over to the rest of the industry and becomes social knowledge that acts as an external effect in enhancing the productivity of all firms. With the spillover effect of R&D, a constant or decreasing returns to scale aggregate production function may exhibit increasing returns to scale and thus may lead to sustained long-run growth (Romer, 1986).

However, Cohen and Levinthal (1989) among others argue that while knowledge from private R&D capital spills over to create social or public domain knowledge, a firm must invest in private R&D to acquire the technical capability needed to make use of the public domain knowledge to enhance its productivity. One implication of this latter view is that industry-wide knowledge will not contribute to private productivity gains unless the receiving firm invests in its own R&D.

It should be noted that studies in this area are not in the context of multinationals. Thus it is interesting to examine, for example, whether the R&D carried out in parent firms has an impact on the productivity of the corresponding subsidiaries.

### **3.4 Technology transfer by multinationals: previous works**

The literature on multinational enterprises and FDI suggests that knowledge-based assets are the key source of ownership or firm-specific advantages held by multinationals. The MNE sets up and operates affiliates abroad to earn rents on its

store of knowledge. The creation and exploitation of that knowledge is the main reason for the growth of most multinationals (see, for example, Dunning, 1988a and Caves, 1996). As noted previously and as highlighted by Buckley and Casson (1985), due to market imperfections and transaction costs, MNEs prefer to exploit their knowledge-based assets within their own organisations rather than across markets. Given the general acceptance of this theoretical point, it is somewhat surprising that so little empirical work has been conducted on intra-firm technology transfer.

Mansfield *et al* (1979) examine the extent to which returns from US parent R&D can be attributed to “foreign application” such as the use of technology in foreign subsidiaries, licensing, or exports of goods embodying the technology. They find that approximately 30 per cent of the returns to R&D come from all of these applications. The extent of technology transfer to foreign subsidiaries and its impact is not however measured individually.

Mansfield and Romeo (1980), Blomstrom (1990) and Globerman (1994) suggest that technology transfer within the MNE does take place. However, these studies make no attempt to measure the benefits affiliates gain from using parent R&D. Zejan (1990) finds a positive relationship between parent company and affiliate R&D intensity, but the impact of R&D on productivity is not discussed.

Recently Fors (1996, 1997) has investigated the use of technical knowledge generated in both the home and foreign plants of Swedish multinationals. Like Mansfield *et al* (1982), Fors recognises that theoretically two directions of technology transfer can be identified. One would expect the direction of technology

transfer to be mainly from the MNE's home base to its foreign subsidiaries. As Fors (1996) and Blomstrom *et al* (1997) point out, the home base is the main location of the MNE's R&D efforts, and home R&D is more basic and long-term in character compared to R&D in foreign subsidiaries<sup>4</sup>. However, the reverse transfer of technology from subsidiary to parent is also a possibility. Fors' findings indicate that the R&D undertaken by Swedish MNEs in their home country is used as an input in both their home and foreign plants, enhancing productivity growth. No evidence is found however, that R&D undertaken in foreign affiliates is transferred to home plants.

While the R&D costs associated with the generation of new technology have long been recognised as substantial, the marginal costs of the additional use of technical know-how have in some sections of the literature been regarded as trivial. In fact low transfer costs leading to spillover benefits for rival firms have raised issues surrounding the appropriability of returns to private firms' R&D efforts. Arrow (1962) argued that such appropriability problems led to under investment by private firms in basic scientific research. Fors (1997, p.341) states in the empirical work cited above that 'technological knowledge is to some extent a public good within the MNE.'

Recently however, the literature on innovation has focused on the considerable costs associated with the transfer of applied technical knowledge. Earlier studies by Teece (1976) and Behrman and Wallender (1976) recognize the importance of host country variables in influencing transfer costs. They argue that the higher the level of education and labor skills in the host country, the lower the expenses for in-house training

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<sup>4</sup> Dunning and Wymbs (1999) find foreign-based R&D to account for 22% of global R&D of 106 MNEs.

and expatriate experts, and the shorter the learning process that is necessary when innovations are introduced.

Teece (1977) was one of the first to detail the costs involved in transferring technology from plants in one country to those in another. He defined the cost of transfer to include both transmission and absorption costs, which could be considerable when technologies were complex and recipient firms did not have the capabilities to absorb the knowledge. Teece explained that while some aspects of a technology could be embodied in equipment and blueprints, “tacit” knowledge was also required to utilise technology efficiently.

Teece’s (1977) work, which was based on 26 international technology transfer projects, acknowledges the importance of the attributes of both the transferee and the transferor of knowledge in the transfer process. With regard to the transferee, Teece suggested that transfer costs would decline with firm size as larger firms had a wider range of managerial and technical staff to assist in the process. Wang and Blomstrom (1992) develop a model of international technology transfer where competition from host country firms pushes MNEs to transfer more technology to their affiliates. The implication is that the magnitude of technology transfer is positively related to the competence of local firms. Katrak's theoretical model (1991) argues that the extent of technology transfer is associated with a subsidiary's learning capability, competition and market rivalry in the host country.

Another critical factor was the extent to which the technology was completely understood by the transferor. The number of previous applications in which the technology had been used increased understanding and lowered transfer costs.

Davidson (1980, 1983) concludes that the time between the first commercialization and the first transfer is shorter when the MNE has previous experience of technology transfer, and that firms with higher than average R&D expenditures are likely to transfer their technology to affiliates rather than to outsiders.

The nature of the technology itself has also been identified as having an influence on the transfer process. Mansfield (1984) argued that firms would be more reluctant to transfer process technology than product technology. This was because process technology might be illegally imitated without detection. On the other hand, Teece (1977) found that it was possible to embody sophisticated process technology in capital equipment, which facilitated the transfer process. Zander (1991) studies the impact of technology characteristics on transfer timing in closer detail. His findings indicate that transfers take place earlier when the technologies are articulable, i.e. easily expressed in manuals and documents.

Following Teece, Cantwell (1994) has recently emphasised the “technological competence” of the receiving firm as an important factor affecting the successful transfer of knowledge. The receiving firm’s own technological capabilities increase its capacity to absorb knowledge from senders. Cantwell’s argument is based on an evolutionary perspective of the firm (see Nelson & Winter, 1982), where skills and routines associated with the application of technology are learned over time. This tacit component of technology is strictly complementary to the codifiable (information and patented blueprints) and tradeable component of technology which we associate with R&D activities. In building a theory of “technological competence” Cantwell views innovation as a cumulative process - much of the capacity for learning being dependent on what is already known.

Human capital is an important element of the receiving firms' technological competence. As pointed out by Cantwell and Dunning (1991), modern MNEs in Europe and the USA have tended to place an increasing emphasis on the adaptation rather than the creation of new technology. This required them to give greater weight to better organizing and managing technology. Local firms' access to MNEs' knowledge would be enhanced if the local labour forces are very productive and they can absorb the foreign investor's knowledge efficiently.

### **3.5 Data, model and estimation techniques**

#### **3.5.1 Data**

The firm level data for the American subsidiaries in Scotland utilised in this study come mainly from the firms' annual reports provided by the FAME database. The list of the names of the American subsidiaries is obtained from Overseas Companies Operating Scotland 1995/96 directory, published by Scottish Enterprise. Among 268 American affiliates in Scotland by 1995/1996, we firstly selected 87 firms for whom the corresponding data for their parent companies could be obtained. After removing firms not in the manufacturing sector, and deleting the affiliates whose data were imperfect, 53 affiliates were left matched with 49 parent companies (some parent firms have more than one affiliate). The data for these US parent firms are from their annual reports submitted to the US Security and Exchange Commission (SEC) which are published in microfish form by Q-data Corp in the USA.

The R&D data available from Q-data Corp are of mixed quality. There are 12 subsidiaries in this sample for which no R&D is reported in the corresponding

parents<sup>5</sup>. This may not be an accurate reflection of their actual expenditure. The standard interpretation of these zeros is that they reflect a censoring problem, and that all firms have some knowledge capital and are doing some new knowledge acquisition, but not necessarily in the form of formal R&D. However, to take logarithm for the variables, this study assumes arbitrarily the R&D expenditure is one thousand US dollars for each of such parents. We feel that such a figure is reasonable, given that the average R&D stock for other parents in this sample is 349 millions US dollars per year. Experiments with the sample excluding firms whose parents report no R&D gave similar parameter estimates, but less precision, as expected, given non-R&D sample firms' characteristics such as industry, size, and capital intensity.

Three different deflators are used where necessary for the above variables. The Scottish subsidiary's output is deflated by Producer Price Index (Economic Trends, 1997). The capital is adjusted using Gross Domestic Fixed Capital Formation Index which was reported by the United Kingdom National Accounts (The Blue Book, 1996). We use American GNP deflator (Main Economic Indicator, 1996) to adjust the R&D expenditures of the US parent firms to constant 1990 US dollars, which is consistent with that used for US official statistics for R&D expenditure.

The panel data set in this chapter include 53 pairs of firms covering four years 1992-1995, yielding a total of 159 observations when growth rates are calculated. The firms broadly cover the manufacturing sector: 3.8% of the observations from food processing, 3.8% from clothing and leather, 1.9% from paper and wood, 1.9%

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<sup>5</sup> This problem is well recognised by research in this field, see, e.g. Bound, *et al* (1984), where no distinction is made among firms whose R&D is "not available", "zero" or "not significant". All such firms are treated as not reporting positive R&D.



from rubber, 9.4% from chemicals, 1.9% from transportation, 7.5% from metal products, 3.8% from non-metal products, 24.5% from machinery, 1.9% from transportation equipment, 37.7% from electronics, and 1.9% from others.

### 3.5.2 Model structure

The model used to estimate productivity growth is a version of Cobb-Douglas production function in its growth rate form. The production function includes the standard factors of capital and labour as well as the additional factor of knowledge capital and human capital. The objective is to attribute the rate of increase in productivity to increases in its inputs. The model shown in equation (3.1) below, follows Griliches (1979) in using a modified version of the Cobb-Douglas production function.

$$Q_{it} = Ae^{\lambda} C_{it}^{\alpha} L_{it}^{\beta} R_{pt}^{\delta} H_{it}^{\gamma} e^{\varepsilon_{it}} \quad (3.1)$$

where  $Q_{it}$  is the output of the  $i^{th}$  subsidiary in period  $t$ ,  $A$  represents a time invariant fixed effect,  $C_{it}$  is the stock of physical capital,  $L_{it}$  is the subsidiary's labour input,  $R_{pt}$  is the stock of knowledge generated by the corresponding parent firm;  $H$  represents the subsidiary's human capital and  $\lambda$  is an exogenous shift variable. The error term  $\varepsilon$ , which varies over individual firms and time, reflects the effects of unknown factors, data approximations and other disturbances. Output elasticities with respect to the four input factors are represented by  $\alpha$ ,  $\beta$ ,  $\delta$  and  $\gamma$ .

In our model, like that of Fors (1996,1997), the knowledge stock available to a subsidiary,  $R_{pt}$  is generated by the parent firm's current and past R&D expenditures.

However, unlike Fors, we do not consider in addition the technical knowledge generated by the subsidiary's own R&D expenditure. Given Taggart's (1996) survey of Scottish subsidiaries, where over half reported to be involved in R&D, this might be seen as an important omission. However Fors' results for Swedish subsidiaries shows their own R&D to have an insignificant impact on productivity when included along with parent R&D. His interpretation is that affiliate R&D is largely aimed at adapting the parent's technology to local conditions. The lack of R&D data for Scottish subsidiaries also precludes us from entering it as a separate variable.

Our model also includes a variable representing the subsidiary's human capital stock,  $H_{it}$ . Here we follow Engelbrecht (1997) who argues that both R&D capital and human capital variables should both be included in empirical investigations of productivity growth. His view is that the human capital variable represents the “other innovation” or the “learning by doing” which takes place as well as other aspects of human capital. Engelbrecht (1997, p. 1481) notes one cannot assume that “innovation through formal R&D is more important than innovation associated with general human capital”. This view is consistent with Cantwell's (1994) argument, discussed in section 2, that technological competence includes both a codifiable element and a more tacit element. The inclusion of the human capital variable may be particularly important in our study, where formal R&D by the Scottish subsidiaries themselves is assumed to be minimal and is not directly entered as an input variable.

In practice, human capital is neither readily quantifiable nor directly observable. Researchers in growth, development, and labour economics have not reached a consensus on the best proxy for human capital. At firm or industry level, a

standard proxy for human capital is wages, which reflect the market's valuation of a worker's education, experience, and other factors (like "innate ability") that determine the worker's human capital level but are unobservable for the econometrician. However, using mean wages as a proxy for human capital is not unproblematic. The relative distribution of average wages across industries reflects not only the distribution of average human capital, but also compensating differentials, or differences in the degree of unionisation.

Another problem involves the potential endogeneity of wages. Suppose economic growth causes high demand for human capital-intensive output, bidding up human capital's relative wage. Then the mean wage would tend to overstate the true amount of human capital of the average worker in any given industry. From an econometrics perspective, as Globerman (1979) and Rault (1995) point out, regressing an output measure of productivity on average wages also raises potential simultaneity problems, since wages may be simultaneously determined with output. Here therefore we follow Hausman (1978) and Rault (1995) and use the residuals from the regression of the log (average wages) on  $CI$  and  $RI$  as the proxy for human capital intensity. This proxy reflects the average wages (therefore labour quality or human capital) that are not explained by all the other explanatory variables.

Simplifying equation (3.1) by rewriting it in terms of labour productivity, and by assuming that  $\alpha + \beta + \delta + \gamma = 1$ , we obtain:

$$\left(\frac{Q_{it}}{L_{it}}\right) = A e^{\lambda t} \left(\frac{C_{it}}{L_{it}}\right)^{\alpha} H_{it}^{\gamma} R_{pt}^{\delta} e^{\varepsilon_{it}} \quad (3.2)$$

Applying a logarithmic transformation and differentiating with respect to time, we have the following linear regression model:

$$\Delta LP_{it} = \lambda + \alpha \Delta CI_{it} + \lambda \Delta HC_{it} + \delta \Delta R_{pt} + \Delta \varepsilon_{it} \quad (3.3)$$

where:  $\Delta LP_{it}$  is the percentage change in labour productivity;  $\Delta CI_{it}$  is the percentage change in physical capital intensity  $\left( \frac{C_{it}}{L_{it}} \right)$  and  $\Delta HC_{it}$  and  $\Delta R_{pt}$  are percentage changes in the human capital and knowledge stocks respectively. By using the rate of change of productivity, firm heterogeneity related to the level of productivity is removed: only the firm-specific growth effects remain.

R&D expenditure data are not available for enough years to calculate the stock of knowledge, therefore following Scherer (1982) and Fors (1996,1997) we transform the production function so that annual R&D expenditure data can be used in the estimations. Given that  $\Delta R$  is the percentage change in the knowledge stock or  $\frac{\dot{R}}{R}$  and, as noted by Terleckyj (1974), that  $\delta = (\partial Q / \partial R)(R / Q)$ , the technical knowledge term from equation (3.2) can be rewritten as  $(\partial Q / \partial R)(\dot{R} / Q)$ , where the first ratio is the marginal product of R&D, which can be estimated as a regression coefficient. Assuming that the depreciation of R&D is negligible,  $\dot{R}$  can be approximated by the annual flow of R&D expenditure. Accounting for these changes we have:

$$\Delta LP_{it} = \lambda + \alpha \Delta CI_{it} + \lambda \Delta HC_{it} + \left( \frac{\partial Q}{\partial R} \right) (RI_{t-1}) + \eta_{it} \quad (3.4)$$

Where  $RI$  is the R&D intensity measured as R&D expenditure in the parent firm divided by the output of the corresponding subsidiary. The List of variables provides a full description of the variable definitions.

In equation (3.4) the parent firm's R&D expenditure in period  $t-1$  affects the labour productivity growth of the subsidiary between periods  $t-1$  and  $t$ . Theoretically this lack of a lag period is problematic given that the international transfer of new technology by a MNE may take some time. In fact Mansfield and Romeo (1980) find that foreign subsidiaries receive new technologies from their parents around six years after they are introduced at home. Empirically however, the lag period adopted is much less of a problem. As Fors (1996) notes, R&D intensities exhibit slow shifts over time. For 15 manufacturing industries Scherer (1982, p.629) reports a simple correlation between company-financed R&D/sales ratios of 0.98 for the years 1973 and 1963. Our own firm-level R&D intensity data show a between firm variance of 32.84 compared with a within-firm variance of 0.06.

Two further points support the lack of attention to R&D lag effects in this study. First, various R&D lag structures seem to have little impact on the estimates (Griliches and Lichtenberg, 1984). In fact, it would be very difficult to define even a relatively appropriate lag structure for mixed industries because of the industry differences with respect to the nature of technology. Second, some studies use only R&D expenditure from the first year of the period under consideration to allow for the lagged effects of R&D. However, R&D intensity is relatively stable over time so the timing of the variable seems to be of little importance in practice (Scherer, 1982 ).

The first part of our analysis of technology transfer estimates equation (3.4) using the full sample of firms. The next part of our analysis breaks the full sample of firms into sub-samples based on particular characteristics, to learn how these characteristics affect the transfer of technology. The subsidiary's turnover per employee ratio is used as a proxy to group the sample into "high" and "low" technology levels<sup>6</sup>. The introduction of this proxy follows Kokko (1994) who assumes that a high level of turnover per employee is the result of the use of a high level of technology. Sub-sample estimates are also conducted for firms operating in product vs. process industries and for large vs. smaller firms.

Similarly the subsidiaries are also grouped in terms of the "size" and "R&D intensity" of their corresponding parents to examine how these characteristics influence the transfer of technology in subsidiaries. The subsidiaries are first divided into two groups, one with parents of "large" size and another with parents of "small" size. At the firm level, the familiar discussion in the Schumpeterian tradition has revolved around the issue of firm size and R&D. Second, the subsidiaries are divided into two groups, based on R&D intensity of their parents-"high" or "low".

### **3.5.3 Summary statistics**

The left-hand part of Table 3.1 documents the beginning and ending average sizes of both of subsidiaries and parents in our panel. On average, while employment grows at the relatively low rate of 2.1 per cent over the four years period, subsidiary turnover grows at 17.5 per cent annually in real term. This implies that subsidiaries increased their labour productivity substantially. The increased productivity in

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<sup>6</sup> The ideal criteria for this grouping is of course the ratio of R&D expenditure to turnover. However, the R&D data is not available.

subsidiaries may be very likely linked to the R&D activities in their parents over the same period. The R&D expenditure grows at 21 per cent annually. However, parent turnover increases only at 10 per cent per year. This may suggest that while transferring technology overseas, parent firms are increasingly locating more production abroad. The magnitude of standard deviations (S.D) of all the variables reflects a wide range of growth rates across firms in different industries.

Summary statistics for the variables used in our models are reported in the right-hand section of Table 3.1. The variance of each variable is decomposed into its between-firm and its within-firm components. The terminology conventionally employed by panel data studies are adopted here: “between-firm” refers to differences in firm-specific average across firms, where the averages are computed over time, and “within-firm” refers to deviations of variables from these firm-specific means.

**Table 3.1**  
**Summary Statistics**

Variable	Mean	S. D	Variable	Variance	
				Between-firm	Within-firm
<b>Subsidiary:</b>					
Turnover,1992	70.601	128.052	Labour productivity	0.596	0.002
Turnover,1995	120.623	274.914	Capital intensity	1.173	0.100
Employment,1992	598	793	R&D intensity	32.841	0.061
Employment,1995	648	932	Human capital	0.102	0.001
Capital,1992	69.712	23.413			
Capital,1995	83.01	24.513			
<b>Parent</b>					
Net sales,1992	2390.632	3421.733	R&D intensity	28.039	0.021
Net sales,1995	3348.100	5540.871			
R&D,1992	238.830	539.092			
R&D,1995	423.102	547.032			

Note: all financial figures reported in millions of 1990 Pounds (subsidiary) or Dollar (parent).

For all the variables, the magnitude of between-firm variance is much larger than that of within-firm variance. The smallest difference between the two variances

occurs in capital intensity variable. This suggests that capital intensity exhibit relatively less variation across firms than R&D intensity. It should be noted that capital accumulates at relatively high rate over the period. The large difference between the two variances for the R&D intensity and human capital variables reflects the fact that technology levels vary considerably among parent firms due to industry differences. Likewise, the labour productivity variable exhibits more variation between subsidiaries than it does within each individual firm over time. All this suggests that, given the short time period, our data set have more cross-sectoral rather than time dimensional features. This finding has econometric implications with respect to the choice of a statistical model for a given panel dataset.

### 3.5.4 Estimation techniques

There are three ways in which estimations can be generated for a panel data set: the pooled ordinary least squares (POLS) model, the fixed effects (FE) and the random effects (RE) model. The three models differ mainly in their assumption concerning the intercept and error terms. In equation (3.4), following the methodology discussed in chapter one,  $\eta_{it}$  is assumed to be decomposed into two independent terms:  $\eta_{it} = u_i + v_{it}$ . In the POLS model,  $u_i$ s are treated as one of the regressors and constrained into one constant  $u$ . In other words, all firms are assumed to take the same value for the level of technology. This is a very restrictive assumption although it is straightforward to estimate.

There is considerable debate regarding the choice between the FE and RE models<sup>7</sup>. A habitual and convenient way forward is to regard the FE regression as a

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<sup>7</sup> See for example, Griliches and Mairesse (1984), Mairesse and Sassenou (1991) and Raut (1995).



better and less biased one since the FE model treats  $u_i$  as regressors rather than relegating them to an error term. However, the FE model is less efficient than the RE model because the former uses variations in the data within each firm through time, and therefore introduces a large number of dummy variables to the regression. In addition, the FE model exacerbates the multicollinearity problem. While the RE model assumes that  $u_i$  is uncorrelated with regressors, the violation of this assumption may lead the RE model to produce biased and inconsistent estimates (Judge *et al*, 1985).

Following Baltagi (1995) and Greene (1997), three tests are applied to choose the best statistical model: the Likelihood ratio (LR) test for the POLS model against the FE model, the Lagrange multiplier (LM) test for the POLS model against the RE model, and the Hausman specification (HS) test for the RE model against the FE model.

For testing the hypotheses about fixed effects, the LR test statistic, under the null hypothesis  $u_1 = u_2 = \dots = u_n = u$ , is:

$$LR = NT * \log\left(1 + \frac{RSS_r - RSS_u}{RSS_u}\right) \sim \chi^2(N-1) \quad (3.5)$$

where  $RSS_r$  and  $RSS_u$  represent the residual sums of squares in the restricted and unrestricted models respectively. In this case, the restricted model is the POLS and the unrestricted model is the FE. A large value for the LR statistic argues in favour for the FE model over the POLS model.

If individual effects do not exist, POLS estimators are best linear unbiased, and GLS estimators are inefficient. To choose between the POLS and RE specifications, Breusch and Pagan (1980) have derived a LM test for the null hypothesis  $\sigma_u^2 = 0$ . They show that

$$LM = \frac{NT}{2(T-1)} \left[ 1 - \frac{v'(I_N \otimes J_T)v}{v'v} \right]^2 \quad (3.6)$$

is asymptotically distributed as  $\chi^2(1)$ , where  $v$  is the vector of residuals,  $I_n$  is an identity matrix of dimension  $N$ ,  $J_t$  is a matrix of ones of dimension  $T$  and  $\otimes$  denotes Kronecker product. A large value of the LM statistic argues in favour of the RE model against the classical regression with no individual components.

To choose between the FE and RE models, we test the hypothesis that  $u_i$  and the regressors are uncorrelated. Under the null hypothesis that the RE model is the correct specification, the HS test is based on the Wald criterion:

$$HS = [b_{fe} - b_{re}]' Var[b_{fe} - b_{re}]^{-1} [b_{fe} - b_{re}] \sim \chi^2(k) \quad (3.7)$$

where  $b_{fe}$  and  $b_{re}$  are estimators of regressors in the RE and FE model respectively,  $k$  is the number of the regressors and  $Var$  is the variance-covariance matrix. Again, a large value of the Hausman statistic favours the FE model over the RE model.

### 3.6 Empirical results

Table 3.2 presents the results from estimation of equation (3.4) using the POLS, FE and RE statistical models. The estimates are made on the entire sample of 53 firms for the period of 1992-1995. The significant coefficients on the R&D intensity variable in all cases suggest that parent R&D capital has a positive significant impact on the changes in productivity of their corresponding subsidiaries,

and thus offers strong support to the assumption that US parents transfer technologies to their affiliates in Scotland.

The highly significant coefficients for the human capital variable in all cases imply that the transferred technologies represent only a part of the knowledge input contributing to the productivity growth in the subsidiaries, and that the human capital variable accounts for another important part. In all the three models, human capital plays an even more important role than parent R&D.

**Table 3.2**

**Results of POLS, FE and RE Estimations for the Full Sample**  
(Dependent Variable: Growth of Labour Productivity ( $\Delta LP$ ))

Variables	POLS	FE	RE
$CI$	0.1199 (0.0696)*	0.0831 (0.0944)	0.1145 (0.0828)
$RI_{t-1}$	0.17350 (0.0855)**	0.2504 (0.1448)*	0.1824 (0.1051)*
$HC$	0.5516 (0.1348)***	0.6856 (0.1746)***	0.5756 (0.1592)***
<i>Constant</i>	0.0626 (0.0466)		0.0653 (0.5852)
$\overline{R^2}$	0.1346	0.2349	0.1343
Std. Error	0.4353	0.5021	0.5108
Tests	LR: $\chi^2[52]=19.594$		
	LM: $\chi^2[1]=18.18***$		
	HS: $\chi^2[3]=2.86$		

Note: (1) \*, \*\*, and \*\*\* denote significance at 10%, 5% and 1% levels respectively. (2) figures in parentheses are standard error.

Unsurprisingly, different significance levels and parameter magnitudes are obtained from the three different statistical models. However, while LR is not statistically significant, significant LM statistics and insignificant HS statistics both support the RE model. Therefore only RE estimation results are presented for the following sub-sample analysis.

Table 3.3 presents the random effects ( RE ) estimated results of equation (3.4) using sub-samples grouped in terms of the characteristics of subsidiaries. The subsidiaries are divided into three pairs: “Product industries” and “Process industries”, “Large size” and “Small size”, and “High-tech level” and “Low-tech level”. Subsidiary size is measured by the average turnover over the period covered. The measurement of the technology level is proxied by the level of labour productivity, as discussed in the preceding section.

**Table 3.3**

**Results of RE Estimations for Sub-samples: Subsidiaries' Characteristics**  
(Dependent Variable: Growth of Labour Productivity ( $\Delta LP$ ))

Variables	Product industries (1)	Process industries (2)	Large size (3)	Small size (4)	High-tech level (5)	Low-tech level (6)
<i>CI</i>	0.1630 (0.0680)**	0.1159 (0.0979)	0.0592 (0.0483)	0.2275 (0.1300)*	0.2832 (0.1230)**	0.0781 (0.0496)
<i>RI<sub>t-1</sub></i>	0.1237 (0.0658)*	0.2142 (0.1537)	0.6031 (0.0800)***	0.2610 (0.2993)	0.4431 (0.1081)***	0.0205 (0.0552)
<i>HC</i>	0.2600 (0.1421)*	0.7916 (0.1740)***	0.1255 (0.0994)	0.9941 (0.2237)***	0.8341 (0.1866)***	0.0880 (0.1088)***
Constant	0.0339 (0.0403)	0.0830 (0.0433)*	0.0700 (0.0291)**	0.0478 (0.0650)	0.0167 (0.0549)	0.0436 (0.0328)
$\overline{R^2}$	0.2224	0.2544	0.1529	0.1431	0.2316	0.1801
Std. Error	0.6036	0.1863	0.3510	0.5625	0.4137	0.4936
NT	111	48	81	78	81	78

Note: (1) \*, \*\*, and \*\*\* denote significance at 10%, 5% and 1% levels respectively; (2) figures in parentheses are standard error. (3) Product industries include: Electronics, Metal product, Machinery, and Transportation; Process industries include: Food processing, Clothing and leather, Paper and wood, Rubber, Chemical and Non-metal product.

Table 3.3 shows first that, the estimated parameter of R&D intensity in column (1) is positive and significant at the 10% level, while it is not in column (2). This is in line with Fors (1996) and Mansfield (1984). The latter finds that firms in the process industries are more hesitant to transfer technology to foreign affiliates as compared with firms in product industries, because the transfer of process technology

may involve higher transaction costs associated with the difficulties of preventing competitors from illegal imitation.

The estimated parameter for R&D intensity in large-sized subsidiaries is significant at the 1% level. This is strong in contrast to the case of the smaller size group where parent R&D plays insignificant role in enhancing productivity. This suggests that the extent to which technology is transferred is a positive function of the subsidiary size. A possible explanation from transaction cost theory is that transfer costs decline with firm size since larger firms generally have a wider spectrum of technical and managerial talent available for assistance during the transfer (Teece, 1977). Another explanation lies in the parent's strategy with respect to their subsidiaries. Smaller subsidiaries typically operate to supply an European or even UK national market. However, their larger counterparts may play a different strategic role. They may be part of a global strategy to internalize the benefits of R&D undertaken in the home country. It could also be argued that in small subsidiaries where economies of scale are less important, and where custom-built items are produced for local markets, the parent's technology may be less relevant.

The results associated with high-tech and low-tech level subsidiaries are similar to those for firm size. The coefficient for R&D intensity is highly significant in relatively higher technology subsidiaries and is insignificant in relatively lower technology subsidiaries. This implies that the degree of technology transfer is a positive function of the technical capabilities of the subsidiaries. This finding is consistent with many previous studies (see, e.g. Wang and Blomstrom, 1992, Kokko, 1994) which argue that the extent to which transferees absorb advanced technologies

depends largely on their own technological capabilities. It is particularly interesting to note the relationship between the two parameters of R&D intensity ( $RI$ ) and human capital ( $HC$ ). A significant R&D intensity variable (human capital) is accompanied by an insignificant human capital variable (R&D intensity) in all groups except the ones representing product and high-tech industries. Given that the common nature of the two variables in representing “knowledge”, our tentative explanation is that, in some firms “knowledge” is mainly embodied in “codifiable technology” generated by R&D, while it is mainly reflected in labour quality in others. Subsidiaries that are in process industries, which are relatively smaller in size, and which are relatively lower in technology level, do not seem to benefit from the technology of their parents. Instead human capital represents the major knowledge input for them. On the other hand, in product industries, those in which the technology level is high, “technology” and “labour quality” play equally important roles. It is reasonable to assume that product R&D is more complicated than process R&D and therefore the labour quality of the transferee will be an important determinant of the ease with which technology can be absorbed.

In Table 3.4, the subsidiaries are grouped according to two pairs based on their parents’ “size”, and “R&D intensity” respectively. The former is measured by net sales, and the latter is measured as the ratio of R&D expenditure to net sales.

The results reported in Table 3.4 have some similarities with that reported in Table 3.3. Columns (1) and (2) in Table 3.4 indicate that there are significant differences between large and small sized-parent firms with regard to the extent to which they transfer technologies overseas. The transfer of technology from the large-sized parent firms has a significant impact on the productivity of their subsidiaries.

**Table 3.4**

**Results of RE Estimations for Sub-samples: Parents' Characteristics**  
(Dependent Variable: Growth of Labour Productivity ( $\Delta LP$ ))

Variables	Large size (1)	Small size (2)	R&D-intensive (3)	Less R&D-intensive (4)
<i>CI</i>	0.1223 (0.0482)***	0.0385 (0.1614)	0.1795 (0.0725)**	0.2079 (0.0936)**
<i>RI<sub>t-1</sub></i>	0.2737 (0.0735)***	0.0214 (0.0702)	0.1344 (0.0653)**	0.1381 (0.1661)
<i>HC</i>	0.3127 (0.1905)*	0.1763 (0.1306)	0.1564 (0.1314)	1.0047 (0.2503)***
<i>Constant</i>	0.0679 (0.0400)*	0.1218 (0.0654)	0.0266 (0.0449)	0.0375 (0.0447)
$\overline{R^2}$	0.2563	0.3678	0.1606	0.1726
Std. Error	0.2778	0.1653	0.3796	0.3541
NT	81	78	81	78

Note: (1) \*, \*\*, and \*\*\* denote significance at 10%, 5% and 1% levels respectively; (2) figures in parentheses are standard error.

This is probably firstly because large parents do more R&D, as asserted by Schumpeter (1950) and Galbraith (1957), who suggest a positive link between firm size or monopoly power and innovative activity. The results in columns (3) and (4) show that R&D intensive parents significantly transfer technologies while those less R&D intensive ones do not. Together with the evidence in columns (5) and (6) of Table 3.3 concerning the affiliates, it is clear that both parents and affiliates have similar patterns of research activity: research-intensive affiliates have research-intensive parents<sup>8</sup>.

The evidence from Tables 3.3 and 3.4 suggests that technology transfer is related both to the technology levels and sizes of both parents and subsidiaries. Irrespective of the characteristics of their parents, the complementary relationship

<sup>8</sup> Lall (1979) found that research-intensive parents have research-intensive affiliates, which is consistent with our finding.

between R&D intensity and human capital in Table 3.2 still holds in Table 3.4, with an exception in column (2).

### **3.7 Conclusions**

Theories of FDI and multinational enterprises hold that the core competence of MNEs rests on their proprietary assets, and that MNEs establish subsidiaries abroad to make use of these assets. The empirical findings of this study lend some support to these theories. Due to rather small sample of firms and to our use of a number of proxy variables, the findings must be viewed with some caution. However, the estimation results do reveal some interesting relationships, which should encourage further study. The characteristics of subsidiaries that ease the transfer process and the complementary roles of human capital and formal codifiable technology in the growth process need to be further explored.

The findings also point to some interesting policy implications regarding the relationship between development and inward investment. The multinational subsidiary may indeed play a pivotal role in the development process as the “technological receiver” of foreign know-how. Our study shows that technology generated by US parents is transferred to their Scottish subsidiaries, as demonstrated by the superior labour productivity growth of these subsidiaries. However, the results also show that technology transfer cannot be taken for granted. Technology is more likely to be transferred from large and R&D-intensive parents to subsidiaries in product industries; those that are larger in size and those that already exhibit a high level of technological competence.



These characteristics of subsidiaries, which enable the transfer process, should be of importance to policy makers at the regional and local level. The results imply that the acquisition of advanced foreign technology cannot be obtained through inward investment on its own. Rather policies to encourage “developmental subsidiaries” with technological capabilities of their own need to put in place. In this respect recent policies to link local companies with universities and research institutes within their region and to form local networks of firms requiring complementary technologies are welcome.

In this chapter our primary concern has been the “intra-firm” transfer of technology between a foreign parent and its subsidiary. In the next chapter we consider technology “spillovers” from the multinational subsidiary to other local firms in the same industry.

## CHAPTER 4

### PRODUCTIVITY SPILLOVERS FROM FOREIGN PRESENCE

#### 4.1 Introduction

The role of foreign direct investment (FDI) in international technology spillovers and economic or productivity growth has long been the interest of academics and policy-makers. Though technology can be diffused via various means, it is sometimes suggested that the most significant channels for the dissemination of modern technology are external effects or “spillovers” from FDI, rather than formal technology transfer agreements [see for example, Blomstrom, 1989].

There are a number of econometric investigations of technology spillovers via FDI from developed to developing countries. Examples include Blomstrom and Persson (1983), Kokko (1994), Blomstrom, Kokko and Zejan (1994), Blomstrom and Wolff (1994) and Kokko (1996) for Mexico, Haddad and Harrison (1993) for Morocco, and Kokko et al (1996) for Uruguay and Aitken and Harrison (1999) for Venezuela. In contrast, similar studies on technology spillovers between developed countries are relatively limited. Caves (1974) and Globerman (1979) examine spillovers from FDI in Australian and Canadian manufacturing industries respectively. Hejazi and Safarian (1999) compare the importance of trade and FDI as channels through which R&D spills-over from G6 to the OECD countries. These and other studies have revealed a variety of important links between FDI or R&D of foreign owned firms and host country local sectoral or overall productivity, but with inclusive results for the effects of FDI on the latter.

Within the UK manufacturing sector, productivity spillover effects have been reported but no consensus made. Davies and Caves (1987) explain why some British industries perform better than others relative to their American counterparts. They emphasise the influence of competitive forces in the form of foreign rivals in both home and export markets. In these contested markets, UK firms are under pressure to promote efficiency and increase their productivity. In contrast, in Driffield (1999), any attempt to improve productivity is likely to occur through factor substitution. His study shows that inward investment has little effect on domestic capital intensity and therefore he concludes that inward investment does little to stimulate productivity growth in the domestic sectors.

Taking an evolutionary perspective, Perez (1997) argues that the consequences of foreign presence change according to market and technological conditions. Perez looks at the relationship between the technology gap and technology spillovers from foreign owned to UK owned firms, and finds that a firm's capability to absorb foreign technology depends on its existing level of technological competence, and its learning efforts. He disagrees with the laissez-faire view about in-flowing FDI as the optimal policy prescription. Instead, it is suggested that the positive effects associated with foreign presence might only be enhanced by encouraging technological co-operation between foreign and indigenous enterprises or by financing R&D efforts by indigenous firms.

This chapter aims to investigate the impact of the presence of foreign owned firms on productivity of UK locally owned firms in manufacturing industries using a

panel data set, which covers 48 3-digit SIC industries over the 1991-95 period. This should contribute to the empirical evidence on spillover effects in situations where the host is a developed country. The Caves -type production function model (e.g. Caves, 1974; Kokko et al, 1996) is augmented by adding the intangible assets of domestic firms as an explanatory variable to proxy R&D stock or their accumulated investment in technology. Together with other new independent variables, the model developed in this chapter serves to test for the impact of technology spillovers resulting from the very presence of foreign-owned firms in industries. Industries are then divided into sub-samples, based on their technological characteristics, to further explore the relationship between the technological competence of local firms and the extent of spillover effects. The literature review is provided in section 4.2. The third section describes the data and the various econometric specifications used to test the model. Empirical results are presented in section 4.4 and conclusions are offered in section 4.5.

## **4.2 Determinants of spillover effects**

In recent years theoretical work on spillovers has been focused on investigating the determinants of the rate of technological diffusion in a country hosting FDI, as well as policy implications. The rate at which new technology is diffused may be an increasing function of the degree to which the host country is open to FDI, measured by the proportion of foreign capital operating in the host country to domestic capital in that country (Findlay, 1978). This is the so-called contagion effect: the diffusion of technology can be seen as an analogy with the spread of a contagious disease. Technical innovations are most effectively copied when there is personal contact between those who already have the knowledge of the innovation and those who eventually adopt it.

There are conflicting views on the relationship between the rate of diffusion and the gap between the level of technology in the multinational's home country and the country hosting FDI. In Findlay (1978) and Wang and Blomstrom (1992) the rate at which new technology is diffused is an increasing function of the gap. The larger it is, the greater the potential for "catch-up". This set of models addresses the incentive to annex knowledge and narrow the gap. On the other hand, Lapan and Bardhan (1973) argue that spillovers are negatively related to the technology gap between the relatively "backward" host country and the "advanced" home country, due to the fact that the superior technology may not be appropriate for the backward country. Perez (1997) indicates that local firms' productivity growth is inversely correlated with the initial technological gaps. This implies that MNE activity would reinforce diverging development patterns. Recent empirical and theoretical literature demonstrates that a firm's ability to follow and adapt to new technological developments depends on its existing technological capability (Cohen and Levinthal, 1989; Cantwell, 1993). Thus, the hypothesis of the existence of "advantages of backwardness" ensuring to backlog firms faster rates of productivity growth has been partly replaced by the idea that "success breeds success".

In Perez (1997), it is argued, that in most of the cases a given rate of average productivity growth by domestic firms might be associated with very different initial conditions: a large number of technologically backward local firms or a predominant presence of technologically developed domestic competitors. However, while in the first case the productivity growth by domestic firms is mainly due to the crowding-out

of domestic enterprises, in the second case it is principally associated with the competitive upgrading of the indigenous industry.

The main problem arising from the above discussion is to find a way to take into account: (1) the positive relationship between technological disparities and the opportunities for improving the technological level of domestic firms by the imitation of foreign technologies suggested by the “advantages of backwardness hypothesis”; and (2) the negative relationship that links technological disparities with the ability of indigenous firms to appropriate technological spillovers from foreign MNE affiliates. A reasonable way to deal with this problem is to assume a non-linear relationship between spillovers and the size of the technology gap. Spillovers increase as the technology gap widens up to a certain critical level. Beyond this level spillovers begin to fall because technological competence by indigenous firms will be too low to exploit fully the technological opportunities arising from foreign presence, and at some still higher level may become negligible or even negative.

The rate of technology diffusion depends largely on the ability of recipient firms to absorb information, which is stressed in an increasing number of recent studies. Das (1987) argues that in the very presence of MNEs the native firms in the same sector learn from the former and become more efficient. This learning process in fact constitutes a major gain for technologically backward host country firms from the presence of MNEs. Cohen and Levinthal (1989) and Cantwell (1993) emphasise that a firm’s ability both to follow and to adapt the technological developments of other firms depends on its existing technological capability. Wang & Blomstrom (1992) point out that the majority of spillovers do not arise automatically from the presence

of foreign firms. Instead, to benefit indigenous firms need to invest in “learning activities”. Taking an evolutionary approach, Perez (1997) argues that the ability of indigenous firms to “catch-up” depends on their level of technological competence. This competence is characterised by “path-dependency” - the absorptive capacity of indigenous firms depends on their past accumulation of technology.

The first econometric test for productivity spillovers from FDI was carried out by Caves (1974) using cross-sectional Australian manufacturing data for 1966. The basic hypothesis was as follows: given external effects, productivity levels should be higher (*ceteris paribus*) in the domestic sectors where multinational firms account for larger share, where their productivity advantage over the domestic rivals is relatively great, or where their share has been increasing. The dependent variable, productivity in the home-owned sectors of Australian manufacturing, was measured by value-added per worker. Explanatory variables included the payroll per worker in the home-owned sector relative to the subsidiary sector, relative capital rentals per worker in the two sectors, a firm size variable, a measure of import intensity, and most important for our purposes the foreign-owned firms’ share of industry employment. His results indicate that the very presence of foreign firms has a positive impact on the labour productivity in the corresponding industries.

Similar studies by Globerman (1979) for Canada, by Blomstrom and Persson (1983), Kokko (1994), and Blomstrom and Wolff (1994) for Mexico, and by Kokko, et al (1996) for the Uruguayan manufacturing sector, confirm Caves’ findings. On the other hand the study of Haddad and Harrison (1993) for Morocco and Aitken and Harrison (1999) for Venezuela conclude that foreign presence has no significant

effect on local labour productivity. Haddad and Harrison conclude that large technology gaps inhibit spillovers from FDI to local firms in Moroccan manufacturing. The examination of local firms' responses to the entry and presence of US multinational firms in European countries by Cantwell (1989) also implies that spillovers are the most important in those industries where the technology gap is small, i.e. where the local firms are technologically strong enough to challenge the US firms. Kokko (1994) concludes in his Mexican study that large productivity gaps and large foreign market shares together appear to be significant obstacles to spillovers.

Perez (1997) examines the non-linear relationships between observed rates of average productivity growth by indigenous firms and spillovers for the case of the UK. He regresses the productivity growth of locally-owned firms against a quadratic function of the initial technology gap. The evidence from his study shows that, indigenous firms' productivity growth and the ability to catch-up with foreign MNEs are inversely correlated with the initial productivity gap.

### **4.3 Models, data and methodology**

#### **4.3.1 Data**

The empirical data used in the present study are mainly taken from FAME database. The firm level data are aggregated to the 3-digit industry level and are adjusted by the Implied Gross Domestic Product Deflator (Economic Trends, 1996).

Of the 103 3-digit manufacturing industries listed in SIC (1992) five are discarded from the sample because of no entry on the database and another 19 are dropped because of no foreign presence in the period of study. Finally another 31 are



removed because of data imperfections, among which 22 are dropped because of incomplete data on intangible assets. As a result, this study uses a panel data set, which contains 48 industries in the UK manufacturing industry for the period 1991-95.

The data are broken down by ownership. Following Caves (1974) foreign-owned firms are defined as those filing at UK Companies House where at least 50% of the share capital is in foreign ownership<sup>9</sup>. For each industry, statistics for locally-owned firms are acquired by subtracting those for foreign firms from the total. The sample (1995) contains 14,105 firms that account for approximately 75% of the total number of manufacturing firms in the database, 72% of turnover, and 75% of employment. Thus the sample is fairly representative of UK manufacturing industry.

Table 4.1 provides an overview of the independent variable of principle concern, foreign presence, for the entire period and for all 48 industries. The variable was measured in the following two ways: (1) the ratio of physical capital stock in foreign subsidiaries to total physical capital stock in the entire industry; and (2) the ratio of foreign subsidiaries' employment to total employment in each industry. Table 4.1 shows that foreign presence varies considerably among industries. Focusing on the foreign share of employment, there are eight industries where the share is greater than 20 percent. It should be noted that while the two measures of foreign presence usually are quite similar in magnitude, in a few industries they vary considerably. For example, foreign firms have a much larger share of capital than they do of labour in

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<sup>9</sup> Foreign ownership is now widely defined as 10-15% foreign share holding.

**Table 4.1**  
**Summary Statistics**

<b>Industry</b>	<b>Foreign share of employment</b>	<b>Foreign share of capital</b>	<b>Technology Gap (Foreign/UK)</b>
Meat Products	0.021	0.020	2.47
Fruit & Vegetable Processing	0.021	0.399	1.51
Prepared animal feeds	0.008	0.009	5.24
Beverages	0.087	0.038	5.48
Tobacco	0.083	0.022	1.38
Textiles fibres, spinning	0.015	0.098	1.93
Man-made textiles	0.024	0.049	1.04
Other textiles	0.072	0.073	1.14
Knitted and crocheted articles	0.016	0.011	1.06
Wearing apparel & accessories	0.025	0.039	2.00
Footwear	0.025	0.042	2.06
Paper & paperboard	0.098	0.140	0.99
Publishing	0.048	0.027	1.13
Printing & related services	0.061	0.048	0.97
Paints, varnishes & coatings	0.114	0.176	2.88
Pharmaceuticals	0.096	0.214	1.25
Soap & detergents	0.248	0.310	11.34
Other chemical products	0.140	0.129	1.58
Man-made fibres	0.102	0.115	1.74
Rubber products	0.365	0.412	4.75
Plastic products	0.078	0.079	1.11
Glass & glass products	0.096	0.108	2.21
Bricks, tiles and clay products	0.014	0.008	1.52
Cement, lime & plaster	0.241	0.076	2.74
Basic iron & steel	0.027	0.030	1.44
Precious & non-ferrous metals	0.143	0.132	1.26
Structural metal products	0.073	0.085	1.48
Treatment & coating of metals	0.137	0.132	1.14
Cutlery, tools & hardware	0.142	0.101	1.77
Other fabricated metal products	0.094	0.107	1.04
Machinery for mechanical power	0.193	0.070	0.98
General purpose machinery	0.114	0.118	2.34
Agriculture & forestry machinery	0.031	0.044	3.67
Domestic appliances	0.142	0.121	0.88
Office machinery	0.419	0.389	1.22
Electric motors, generators	0.090	0.114	0.90
Electric equipment	0.067	0.101	1.26
Electronic valves	0.350	0.634	2.66
Television & radio transmitters	0.093	0.109	1.27
Television & radio receivers	0.400	0.491	6.20
Medical & surgical equipment	0.118	0.114	1.27
Instruments	0.134	0.177	1.27
Motor vehicles	0.430	0.537	1.37
Motor vehicle parts	0.217	0.176	0.91
Ships, building & repairing	0.076	0.027	0.93
Railway & tramway rolling stock	0.132	0.148	1.02
Aircraft & spacecraft	0.015	0.007	1.69
Furniture	0.038	0.223	0.87

Notes: (1) Source: FAME database; (2) All ratios are author's own calculations; (3) Technology gap is measured as: Productivity in Foreign Owned Firms/ Productivity in UK Owned Firms. See List of Variables.

the pharmaceutical industry. Regression estimates were obtained using both measures. Because they are very similar, only the estimates using the capital share measure are reported in the next section. The similarity of results may be due to the likeness of factor proportions in foreign and locally-owned firms in UK manufacturing.

Table 4.1 also lists the technology gap in each industry as measured by the ratio of labour productivity in foreign-owned firms to that in UK-owned firms. It shows that UK-owned firms have greater productivity than their foreign counterparts in only eight out of the 48 industries. In 14 industries labour productivity in foreign owned firms is over double that of locally-owned firms. This is consistent with evidence from Barrell & Pain (1997) who estimate that in 1994 the labour productivity of US manufacturing affiliates in the UK was around one-third higher than UK companies on average.

#### **4.3.2 Models**

The analysis begins with the introduction of an augmented Caves-type model of uni-directional industry-level productivity spillovers from FDI as shown in (4.1) below. In this model, labour productivity is measured by value added per worker in UK locally-owned firms (LPD) in an industry, and is influenced by the following variables: (1) physical capital intensity in UK-owned firms (CID), which is normally measured by a capital labour ratio indicating an average level of physical capital stock per capita; (2) human capital in UK-owned firms (HCD); (3) intangible assets per worker in UK-owned firms (IAD); (4) the average size of UK-owned firms in the particular industry (SIZED); (5) the industry concentration ratio (CR); (6) the

presence of multinational firms or foreign presence (FP); and (7) the technology gap (GAP) between foreign and UK-owned firms.

$$(LPD)_{it} = (CID)_{it}^{\alpha} (HCD)_{it}^{\beta} (IAD)_{it}^{\gamma} (SIZED)_{it}^{\delta} (CR)_{it}^{\theta} (FP)_{it}^{\zeta} (GAP)_{it}^{\psi} e^{\varepsilon_{it}} \quad (4.1)$$

Positive relationships are expected between the dependent variable and all explanatory variables except for the concentration ratio and gap whose coefficients may have a positive or negative sign. The productivity of a given firm is an increasing function of physical capital per worker. A higher value of human capital may be seen as evidence of higher learning efforts, or a larger effective labour force. A variable, which is unique to this study, is intangible assets in locally-owned firms. This is a proxy for the stock of knowledge they accumulate over time through R&D investments. Such investments serve to enhance both their own technological capabilities and their “ability to learn” from other firms. The average firm size variable represents economies of scale in the industry.

Given conflicting findings from past studies, the expected sign for the industrial concentration variable is ambiguous. Some argue that the sign should be negative given that industrial concentration leads to collusive bargains that impair incentives to increase productivity (Davies and Caves, 1987, p. 40). However, the opposing view is that firms in more concentrated industries are better able to engage in monopoly pricing, which may lead to a higher level of value added per employee [Blomstrom and Persson, 1983; Kokko, 1994].

Given the main emphasis of this research, we are particularly interested in the coefficient on the foreign presence variable. If spillovers take place, foreign presence

should have a significant positive effect on labour productivity in locally-owned firms. As discussed by Das (1987), the rate of increase in efficiency of the native firms is positively related to the level of activity of the MNE's subsidiary. The larger the scale of operation the greater is the opportunity of the native firms to learn from it.

Also the sign of the gap coefficient may change depending on the local firm's existing level of technological competence and its learning efforts. As in Perez (1997), this relationship is captured by including the *gap* (for the level of technology competence) and *human capital* (for learning efforts) as two explanatory variables. The sign of the gap coefficient varies under different hypothesis. On the one hand, The sign could be positive, according to the “advantage of backwardness hypothesis” discussed earlier; on the other hand, *gap* variable could have a negative sign if it is asserted that a wide technological gap impairs indigenous firms' ability to catch up with foreign competitors (Cantwell, 1989, 1993). As discussed previously, the relationship between the dependent variable and the technology gap may be non-linear.

Applying a logarithmic transformation to equation (4.1), we arrive at the linear regression model shown in (4.2) below:

$$(lpd)_{it} = \alpha(cid)_{it} + \beta(hcd)_{it} + \gamma(iad)_{it} + \chi(sized)_{it} + \theta(cr)_{it} + \zeta(fp)_{it} + \psi(gap)_{it} + \varepsilon_{it} \quad (4.2)$$

where lower cases denote the natural logarithmic transformation of variables;  $\alpha$ ,  $\beta$ ,  $\gamma$ ,  $\chi$ ,  $\theta$ ,  $\zeta$  and  $\psi$  are output elasticities with respect to every explanatory variable respectively; and  $\varepsilon_{it}$  is the combination of intercept and error terms which reflect the

effects of unknown factors. Subscripts  $i$  and  $t$  denote the industry and time period respectively, and in our sample  $i = 1, 2, \dots, N(=48)$ , and  $t = 1, 2, \dots, T (=5)$ .

#### 4.3.3 Methodology

Our analysis of FDI productivity spillovers firstly involves testing equation (4.2) using the full sample of 48 industries to obtain parameter estimates for manufacturing industry in general. A primary objective is to test for the impact of foreign presence on the productivity of UK locally-owned firms.

The next part of our analysis follows Kokko (1994) in grouping the full sample of industries into sub-samples by two different technological characteristics, to determine how these characteristics affect spillovers. First, intangible assets per worker in locally-owned firms (*iad*) in an industry is used as a proxy for the technological capabilities of locally-owned firms. This is in contrast to Kokko (1994) who uses average payments of patent fees in an industry. Intangible assets are used as a criterion to divide local UK firms into two groups in each industry: one having a “high” level of innovative knowledge and hence a “good” capability of imitating or challenging foreign investors, and the other having a “low” level of knowledge and “weak” capability. It is expected that the higher the *iad* value, the more significant the impact of FDI on local productivity.

Finally, the ratio of value added per employee in foreign subsidiaries to that in local UK firms in each industry is used as a proxy for the difference in the levels of technology between foreign and UK-owned firms. The introduction of this proxy is consistent with the discussions of Findlay (1978), Wang and Blomstrom (1992) and

Kokko (1994). The assumption is that a high level of value added per employee is the result of a high level of technology. This division enables us to investigate how the technology gap between foreign and domestic firms affects productivity spillovers from FDI.

The standard Chow test is applied to test the equivalence of the regression estimates for equation (4.2) between sub-samples of industries. If the differences between estimations are statistically significant, then the division of the industries into these sub-samples, based on their technological characteristics is justified.

As in the chapter 3, for each estimation diagnostic tests are applied so that a best statistical model can be selected among the pooled ordinary least squares (POLS) model, the fixed effects (FE) or least squares dummy variables (LSDV) model, and the random effects (RE) model. The details associated with the three specifications and the related various diagnostic tests can be found in that chapter.

#### **4.4 Empirical results**

Columns 1, 2 and 3 of Table 4.2 present the results from estimations of equation (4.2) using the POLS, FE and RE statistical models respectively. The estimates are based on the entire sample of 48 industries for the period 1991-1995. The foreign presence variable, which is of particular interest to this study, has the expected positive sign and is statistically significant in all three models. This suggests that the very presence of foreign-owned firms influences changes in productivity through spillover effects. The coefficients for capital intensity, human capital and intangible assets per worker are also all significant with the expected

positive signs. The results indicate that the productivity of UK-owned firms is influenced not only by their physical and human capital, but also by their own stock of indigenous knowledge, and spillover effects from multinational corporations.

**Table 4.2**

**Results for the Full Sample of 48 Industries**  
(Dependent Variable: Labour productivity in UK-owned firms (LPD))

Variables	(1) POLS	(2) FE	(3) RE	(4) FE	(5) FE
cid	0.3785 (10.690)***	0.1934 (3.273)***	0.2868 (6.607)***	0.2064 (3.547)***	0.1601 (2.747)***
hcd	0.2909 (3.289)***	0.2866 (4.204)***	0.2898 (4.320)***	0.2787 (4.216)***	0.2785 (4.232)***
iad	0.0434 (2.848)***	0.0486 (2.239)**	0.0461 (2.621)***	0.1403 (3.030)***	0.0519 (2.461)***
cr	0.0901 (1.450)	-0.0706 (-0.577)	0.0507 (0.619)		
fp	0.0731 (3.041)***	0.1002 (2.149)**	0.09106 (2.887)***	0.1611 (2.961)***	0.0494 (1.011)
sized	-0.0145 (-0.466)	-0.0344 (-0.491)	-0.0042 (-0.099)		
gap	-0.3532 (-8.932)***	-0.3549 (-8.984)***	-0.3459 (-9.582)***	-0.3695 (-9.516)***	-0.2188 (-3.271)***
fpiad				0.0317 (2.175)**	
fpgap					0.0558 (2.549)***
Constant	2.7036 (7.990)***				
$\overline{R^2}$	0.5653	0.8056	0.5463	0.8098	0.8115
NT	240	240	240	240	240
Tests	LR	LM	HS	LM	LM
Degree of Freedom	47	1	7	1	1
Statistics	193.10***	70.57***	13.16*	73.6***	74.4***

Notes: (1) Figures in parentheses are t statistics (two-tailed tests); (2) \*, \*\*, and \*\*\* denote significance at the 10%, 5% and 1% levels respectively.

The coefficient on the industrial concentration ratio, measured by the share of the industry's turnover accounted for by the largest 5 firms, is statistically insignificant in the three statistical models presented in columns 1, 2 and 3. This insignificance may reflect our particular measure of industrial concentration which,



because of the lack of comparable data, is not adjusted for international trade. It may also be indicative of two counterbalancing forces. While collusive bargains may impair incentives to increase productivity, value added per worker may be increased through monopolistic pricing.

The coefficients on average firm size do not have the expected positive signs in columns 1, 2 and 3 of Table 4.2, but they are also statistically insignificant. This seems to suggest that economies of scale, measured by the average turnover of UK-owned firms, have no impact on labour productivity. The insignificance of this variable may reflect the fact that modern technology has rendered scale effects less important. Alternatively, a better measure of scale economies may be minimum efficient scale (MES), as employed in Blomstrom and Persson (1983). Information on minimum efficient scales for UK industries over our time period was not available.

A significant and negative relationship is identified between the dependent variable and the technology gap in the results for all three models presented in columns 1, 2 and 3. Since the negative sign for the technology gap is estimated from the logarithmically transformed function, the assumed non-linear relationship between labour productivity and the gap is a kind of parabola. However, the average relationship is negative, and the elasticity indicates that when the gap increases by 1%, the productivity of UK-owned firms will go down by about 0.35%.

It is no surprise that different significance levels and parameter magnitudes are obtained from the three different statistical models, since they are normally sensitive to the assumption of unobservable heterogeneity. Following the discussion of the

methodology in the preceding section, the LR statistic of 193.10 is statistically significant at the 1% level, indicating that the FE model is preferred to the POLS model. Similarly, the high value of the LM statistic argues in favour of the RE model against the POLS model, and the large value of the HS statistic suggests that the FE model is better than the RE model. The consideration of all three statistics leads us to choose the FE specification as the best statistical model for the dataset.

The regression estimates shown in columns (4) and (5) each have an added variable to represent the interaction between foreign presence and intangible assets and foreign presence and the technology gap respectively. Both interaction variables are significant with positive coefficients, indicating that further investigation of their relationship is warranted. We undertake this investigation in the sub-sample analysis, reported in Table 4.3. Due to their statistical insignificance, the concentration ratio and firm size variables are dropped in the sub-sample analysis.

As discussed in the preceding section, the technological characteristics of industries may affect the degree of productivity spillovers from FDI to UK-owned firms. The impact of these characteristics may be explored by dividing the industries into sub-samples based on: (1) the intangible assets of UK-owned firms; and (2) the technology gap between foreign subsidiaries and local UK firms.

Standard Chow tests were employed to justify the division of industries into pairs based on: (1) “high” and “low” intangible assets in locally-owned firms; and (2) “high” and “low” technology gaps. The tests show that the divisions are justified. The

F value is 2.127 (statistically significant at the 10% level) for the former group, and 2.891 (statistically significant at the 5% level) for the latter.

The equation 4.2 is re-estimated for two pairs of sub-sample separately and the results are reported in Table 4.3. The results from the first pair of sub-samples are reported in the first and second columns of Table 4.3. In those industries where UK-owned firms have high technical capabilities proxied by high intangible assets (col 1), the coefficient for the foreign presence variable is positive and statistically significant at the 1% level. The LR, LM and HS tests suggest that the FE specification is the best

**Table 4.3**  
**Results for Sub-Samples of Industries**

(Dependent Variable: Labour Productivity in UK-Owned Firms (LPD))

Variables	High iad (FE) (1)	Low iad (RE) (2)	High gap (RE) (3)	Low gap (POLS) (4)
cid	0.2449 (3.075)***	0.2051 (3.118)***	0.3103 (5.413)***	0.2591 (4.498)***
hcd	0.4379 (3.012)***	0.2333 (3.286)***	0.2591 (3.347)***	0.3671 (2.695)***
iad	0.0669 (2.316)**	0.0374 (1.354)	0.0236 (0.922)	0.0686 (4.120)***
fp	0.2355 (2.796)***	0.0327 (0.817)	0.0765 (1.856)*	0.1553 (4.147)***
gap	-0.3864 (-7.286)***	-0.3598 (-6.795)***	-0.3501 (-8.474)***	-0.2755 (-3.379)***
Constant				3.0361 (18.549)***
$\overline{R^2}$	0.8207	0.5418	0.5668	0.5193
NT	135	105	135	105
Tests				
LR	$\chi^2(26) \approx 114.8$ ***	$\chi^2(20) = 77.0$ ***	$\chi^2(26) = 139.7$ ***	$\chi^2(20) \approx 20.8$
LM	$\chi^2(1) \approx 39.2$ ***	$\chi^2(1) = 26.2$ ***	$\chi^2(1) = 69.8$ ***	$\chi^2(1) \approx 0.26$
HS	$\chi^2(5) \approx 10.4$ *	$\chi^2(5) \approx 4.71$	$\chi^2(5) \approx 6.02$	$\chi^2(5) \approx 2.1$

Notes: (1) Figures in parentheses are t statistics (two-tailed tests);

(2) \*, \*\*, and \*\*\* denote significance at the 10%, 5% and 1% levels respectively.

statistical model for this sub-sample. On the other hand, in those industries where UK-owned firms have low technological capabilities (col.2), foreign presence has no significant impact on changes in labour productivity. The diagnostic tests indicate that the RE specification is the best statistical model for that sub-sample.

An important implication of the results from the first pair of sub-samples is that the degree of productivity spillovers from FDI is a positive function of the technological capabilities of UK-owned firms. This is consistent with the findings of Cantwell (1989) who suggests that FDI has the greatest positive impact on local technological progress in industries where local firms have a long technical tradition.

The second pair of sub-samples deals with the impact of the technology gap on productivity spillovers from FDI. Columns 3 and 4 in Table 4.3 show that the effect of foreign presence on labour productivity is statistically significant in both high and low gap industries, however the variable coefficient has a higher magnitude and is more significant when the technology gap is low. These results are consistent with the hypothesis that spillovers are most important when the technology gap is small.

## **4.5 Conclusions**

The empirical literature on FDI related spillovers is substantial but is characterised by the absence of broadly accepted and robust empirical findings. The objective of this study is to examine intra-industry productivity spillovers in the UK manufacturing sector using a recent panel data set. Initially a Caves-type single

equation model is used on the full sample to test for the impact of technology spillovers resulting from the presence of foreign-owned firms. The results indicate that the productivity in UK-owned firms is determined by their capital intensity, learning efforts, technological capabilities, the very presence of FDI and the existing level of technological competence (or technology gap) relative to that in foreign firms'. The evidence suggests that multinational enterprises do generate positive productivity spillovers in UK industries. It also supports one important argument of new growth theory: international integration, in our case through FDI, increases economic growth in the host country.

A further sub-sample analysis of the data set investigates the relationship between the technological characteristics of UK-owned firms and the impact of spillovers. This analysis is especially important given the previous lack of evidence on spillovers from FDI when the host is a developed country. The findings show that: (1) the greater the technological capabilities of local firms, the greater the benefit they can obtain from spillovers from FDI; and (2) that the spillover effect is on average negatively related to the technology gap between foreign and locally-owned firms. The results support the proposition that spillovers are most important in those industries where the technology gap is small, i.e. where local firms are technologically strong enough to challenge foreign investors.

Overall the results from this chapter contribute to the empirical evidence on spillover effects in situations where the host is a developed country. The policy conclusions from this study are straightforward: technology spillovers from FDI have their greatest impact when locally-owned firms are technologically competent. The

technological capabilities of local firms ensure that they are able to absorb the technology used by multinational firms through contagion and demonstration effects. These capabilities also enable them to compete with multinational corporations to the benefit of both categories of firms. Government authorities concerned with maximising technology spillovers from FDI should not ignore their local economic base. Instead measures which encourage the development of local business capabilities through spending on R&D or updating of skills and knowledge should be emphasised. By doing so virtuous cycles of economic development in locations affected by foreign MNC activities may be generated.

## CHAPTER 5

### COMPETITION AND ENDOGENIZED SPILLOVERS

#### 5.1 Introduction

One of the most important results from chapter 4 is that spillovers in manufacturing industries are due to significant positive impact of foreign presence on the labour productivity of locally-owned firms. This finding, though consistent with many previous studies, needs to be carefully considered. According to Kokko (1996), a significant share of spillovers may be endogenous due to the competition between local and foreign firms. In fact, there may be no simple relationship between the size of the foreign share in manufacturing and the extent of spillover effects.

Traditionally, it has been predicted that large spillovers are more likely in industries where there is large foreign presence. Kokko (1996) however, maintains that, when the effects of competition are taken into account, it is obvious that a large foreign presence may arise in industries where local firms are weak and unable to absorb technology spillovers. In contrast, small foreign shares may typify some sectors where considerable spillovers have already taken place and where local firms have become so much more competitive and technologically advanced over time that they have recaptured lost market shares or restricted the expansion of foreign MNEs. The foreign firms that remain may still contribute significantly to spillovers, because the pressure from competitive local firms may force them to upgrade their technologies continuously.

Due to the large size of the technology gap between developed and developing countries, the spillovers are generally assumed to be uni-directional, i.e. from foreign subsidiaries to local owned firms. In many less developed countries local firms may be too weak to mount a competitive response to foreign entry. In such cases, spillovers from local firms to foreign subsidiaries are insignificant or non-existent. In contrast, when the host is a developed country, spillovers may be bi-directional, since local firms in industrialized host countries might be expected to reply to multinational competition where the technology gap is relatively small. A continuing interaction between innovation and productivity growth in foreign and indigenous firms will arise as a result, i.e. spillovers should run in both directions. Indigenous firms will be stimulated by foreign presence, and the technology and productivity of foreign-owned affiliates will be improved in response. When dealing with a developed country, the uni-directional model of spillovers, tested in Chapter 4, may be mis-specified.

While the role of competition in generating spillovers has long been recognised and discussed in almost all related studies (see for example, Caves, 1974; Globerman, 1979; Das, 1987; Blomstrom, 1989; Wang and Blomstrom, 1992; and Eden *et al*, 1997; and Aitken and Harrison, 1999), none of these studies separated the effect of competition from foreign presence empirically. The only empirical research explicitly incorporating the competitive effects or bi-directional effects into a measure of spillovers is the work of Kokko (1996). In his study of FDI in Mexico, Kokko separated spillovers from “competition” and those from “contagion”, placing a strong emphasis on the role of competition between foreign and locally-owned firms. His results show that simultaneous interactions between local firms and MNE affiliates, from which spillovers occur, can be found in some industry sub-samples, but not in



the whole sample of industries. Kokko attributes the insignificance of interactions for the whole sample to the inclusion of “enclaves” where foreign firms operate in isolation from locally-owned firms. However, another possible explanation is that the country Kokko studied, Mexico, is a developing country where spillovers from indigenous firms to those of foreign owned firms may be limited.

This chapter is a continuation of chapter 4. It aims to further investigate the impact of FDI on productivity in UK manufacturing industries by looking at whether there are significant spillover effects from competition in situations where the host is a developed country. The same panel data set, which covers 48 3-digit SIC industries over the 1991-95 period is used. Following Kokko (1996), a set of simple simultaneous equations is estimated to capture possible bi-directional technology spillovers between foreign and UK-owned firms. However, this study differs from that of Kokko (1996) in the following aspects: (1) unlike Kokko, we investigate spillover effects from competition using a case where the host is a developed country; (2) while Kokko (1996, p.208) acknowledges the limitation of cross-sectional data and attributes his failure to draw firm conclusions to the lack of time-series data, this study is based on a panel dataset, which provide much richer information; and (3) our inclusion of additional variables should reduce the misspecification error. In particular, the intangible assets variable is used to proxy technological capabilities built up from accumulated R&D expenditure. The findings from this chapter should contribute to the empirical evidence surrounding Kokko’s theoretical argument about the distinction between the “demonstration-contagion” type of spillovers and spillovers from competition. Section 5.2 reviews the theoretical literature. Models,

data description and methodology are presented in section 5.3. Section 5.4 gives the empirical results and section 5.5 concludes the chapter.

## **5.2 Spillovers from competition**

Competition is generally believed to improve both the static and dynamic efficiency of the production process. In other words, it is supposed to increase both the level and the growth rate of factor productivity. If an increase in competitive pressure reduces the X-inefficiency associated with the production process, it increases the level of factor productivity. Despite the intuitive acceptance that competition improves productivity, it is unclear through which channels this occurs, especially in the case of the existence of foreign firms in a host country. It is therefore particularly interesting to examine the mechanism of competition between foreign and locally owned firms, through which productivity spillovers are supposed to take place.

It has been argued that foreign entry raises the level of competition among firms in the host country's industry, which means that foreign subsidiaries might increase the pressure on domestic-owned competitors to improve technical efficiency. The multinational firm tends to operate in industries marked by product differentiation and high barriers to entry, where the threat of potential competition does not lead to continuous pressure for cost minimization or production at an efficient scale. The multinational itself tends to be an efficient firm, because success in a domestic market is a precondition for attaining multinational status; the multinational firm, especially as a newcomer to a market, is apt to upset the prevailing collusive tranquility and shrivel the quasi-rents that can allow inefficiency to persist.

Also it may squeeze its rivals both through upward pressure on factor prices and downward pressure on product prices.

The pressure exerted by foreign firms will force local firms to introduce new technology or management skills to improve their efficiency, in order to avoid losing market share or even being crowded out of the industry. The productivity growth that follows is considered to be a major spillover effect from FDI. Findlay (1978) notes that contact with MNEs can induce local firms to “try harder” and that “the visible example of a high standard can inspire those with a lower level of achievement to perform better”. Blomstrom's (1986) hypothesis is that the most important influences of MNEs on local firms come from the competition exerted by foreign MNEs.

Taking an evolutionary perspective, Cantwell (1989) developed the theory of “technological accumulation” proposing that technological development within a firm is a cumulative process. Cantwell highlights stylised cases which emerge from extensive empirical research regarding the developed countries (Cantwell, 1993). In industries where the technological tradition of local firms is well-established, domestic firms are generally able to react promptly to foreign threats, to assimilate foreign technologies and to mobilise resources to compete with foreign MNEs in their own home markets. In such cases, the process of technological competition between foreign and domestic firms may generate technological spillovers in both directions through the concentration in these locations of the high-tech phases of production and /or R&D activities by foreign and domestic firms. This usually happens when the initial technological competence of domestic firms is high and they are able to reduce the original gap and are confident in co-existing with foreign firms with some unique

advantages, while the location attracts high-tech foreign MNE productive activities. Technological competition and spillovers interact with one another in a virtuous circle of technological development. Such a virtuous circle of technological development may propel the locally-owned firms towards a new technological frontier.

Cantwell also argues, however, that foreign presence is not likely to produce large spillover benefits for local firms when FDI occurs in industries where foreign firms are strong and locals are weaker and dependent on a protected local market. A low level of technological competence of locally-owned firms will render them unable to meet the technological standards required by foreign firms and, hence, will reduce local sourcing by foreign enterprises with pervasive effects both on the balance of payments and technological spillovers (Dunning, 1986, Dunning and Cantwell, 1986). In their innovation-network model, Ostry and Gestrin (1993) are concerned with the benefits that host country firms gain from R&D co-operation with foreign owned firms. They argue that the interaction of foreign affiliates and host country firms in value-added activities might become less effective if host country firms cannot adjust to the higher organizational and technological requirements of participation in the new corporate structures associated with the development of new technologies. On the other hand, since technology imports are expensive (Teece, 1977), foreign firms will have no reason to import more and newer technologies from their parent companies, if competition from domestic firms does not threaten their market shares and profits. Thus, in such cases, a larger foreign presence may coexist with a slow technology transfer and the transfer of old technologies and, hence, it may result in a low level of spillover benefits for indigenous firms.

In the latter scenario, foreign presence may even reduce the productivity of domestically owned firms particularly in the short run. If imperfectly competitive firms face fixed costs of production, a foreign firm with lower marginal costs may choose to produce more relative to its domestic competitors. As a consequence, entering foreign firms can draw demand from domestic firms. The productivity of domestic firms would fall as they have to reduce production and spread their fixed costs over a smaller market, forcing them back up their average cost curves. If the productivity decline from this demand effect is large enough, net domestic productivity can decline even if the multinational transfers technology or its firm-specific assets to domestic firms. Under these circumstances, the greater competitive pressure generated by foreign presence erodes local firms' profits and hence reduces their investment in learning activities, new machinery and capital equipment. This gives rise to a cumulative process of technological decline in the locations concerned, which eventually leads to a large presence of foreign firms specialised in low-tech productions. Foreign MNEs can easily displace domestic firms, which fall further and further behind and are gradually driven out of world markets in a process of cumulative decline.

The role of competition in generating spillovers has been emphasised in recent theoretical models. Wang and Blomstrom (1992) construct a model where the strategic interactions between foreign and local firms are highlighted. Putting both foreign and local firms in a strategic game, their model clearly spells out the importance of competition and simultaneous interactions between foreign and local firms. An implication from such a model is that competitive interactions between the two types of firms constitute important determinants of the size of spillovers. Perez

(1997) developed an evolutionary model of technological competition between foreign and domestic firms which is able to generate both vicious and virtuous circles of development in locations affected by foreign MNE activities.

The empirical evidence is relatively limited especially when the host is a developed country. Some case studies at the firm and industry level (see, for example, Evans, 1979; Langdon, 1981) described the effects of competition from MNEs on locally owned firms. The two cases refer to developing countries. Kokko (1996) uses a simultaneous equation model to test the hypothesis that the productivity of foreign affiliates and local firms are jointly determined. He finds some evidence that in some sectors of Mexican industry, there are spillovers from competition. It is conceivable that local firms in the less developed countries may be too weak to mount a competitive response to foreign entry, whereas the locals in industrialized host countries can often be expected to reply competitively. Focusing on a developed country, the United Kingdom, Perez (1997) considers two factors affecting the sign of the impact of in-flowing FDI on domestic firms' competitiveness, namely, the original technological gap between foreign and domestic firms and the pace of FDI inflows. Regressing the productivity growth of locally-owned firms against a quadratic function of the initial technology gap, Perez finds that the large technological gap may impair the competitiveness of domestic firms since these firms are not technologically competent enough to be able to absorb foreign technology.

## 5.3 Models, data and methodology

### 5.3.1 Data

The empirical work in this chapter is based on a panel data set covering 48 UK 3-digit manufacturing industries over the 1991-95 period.

Table 5.1 shows the productivity gap and the ratios of factor inputs in foreign - owned firms to UK-owned firms for 48 branches of the manufacturing sector over the period 1991-95. The first column shows that UK-owned firms have greater productivity than their foreign counterparts in only eight out of the 48 industries. In 14 industries labour productivity in foreign owned firms is twice as high as that of locally-owned firms. The average productivity gap is 1.87. All the production factors observed except for the "size" variable contribute to this productivity gap. The second column shows that foreign owned firms enjoy higher physical capital intensity in 30 of the total 48 sectors, with an average gap of 1.62. Column (3) shows that foreign firms also have a higher level of human capital in 34 sectors, with an average gap of 1.31. The fourth column shows that foreign owned firms use about 2.5 times more intangible assets than UK owned firms. This seems likely to be the primary reason for the foreign firms' productivity advantage. The large standard deviation in intangible assets per worker is probably caused by data imperfections associated with this variable. No big difference is observed regarding the size of the two types of firms, although foreign owned firms are slightly bigger on average than those of UK owned ones. It also should be noted that the standard error of the size variable is relatively small. This means that across nearly all the sectors the size difference between the two types of firms is quite small. In fact, the largest gap is 1.26, which

**Table 5.1**  
**Descriptive Statistics (Foreign/UK)**

Industry	(1)	(2)	(3)	(4)	(5)
	Productivity	Capital Intensity	Human Capital	Intangible Assets	Size
Meat Products	2.47	0.94	2.42	0.01	0.95
Fruit & Vegetable Processing	1.51	2.08	1.42	5.43	1.17
Prepared animal feeds	5.24	1.49	1.98	0.57	0.96
Beverages	5.48	0.44	1.34	21.57	1.15
Tobacco	1.38	2.71	0.63	5.43	0.96
Textiles fibres, spinning	1.93	8.65	1.58	0.59	0.94
Man-made textiles	1.04	1.90	1.04	5.30	0.96
Other textiles	1.14	1.04	1.11	3.34	1.05
Knitted and crocheted articles	1.06	0.77	0.98	0.58	0.92
Wearing apparel & accessories	2.00	1.71	1.29	0.27	1.03
Footwear	2.06	1.75	1.38	0.01	0.99
Paper & paperboard	0.99	1.48	1.02	5.01	1.09
Publishing	1.13	0.55	1.10	9.01	1.04
Printing & related services	0.97	0.79	0.91	1.06	1.18
Paints, varnishes & coatings	2.88	3.60	3.29	0.87	0.99
Pharmaceuticals	1.25	8.01	0.95	0.58	0.95
Soap & detergents	11.34	1.37	0.36	12.25	1.12
Other chemical products	1.58	0.91	1.11	5.89	1.03
Man-made fibres	1.74	1.26	1.25	0.68	0.45
Rubber products	4.75	1.02	0.92	0.89	1.07
Plastic products	1.11	2.16	4.51	2.57	0.95
Glass & glass products	2.21	0.61	1.11	1.13	0.79
Bricks, tiles and clay products	1.52	0.26	0.85	0.59	0.79
Cement, lime & plaster	2.74	1.08	0.99	5.86	1.12
Basic iron & steel	1.44	0.90	1.10	0.51	0.98
Precious & non-ferrous metals	1.26	1.18	7.06	2.67	1.03
Structural metal products	1.48	0.98	1.06	4.60	0.91
Treatment & coating of metals	1.14	1.16	0.93	1.08	1.11
Cutlery, tools & hardware	1.77	1.15	1.08	0.53	1.18
Other fabricated metal products	1.04	0.74	0.79	0.94	1.06
Machinery for mechanical power	0.98	1.04	1.03	7.53	0.94
General purpose machinery	2.34	1.11	1.17	11.46	1.02
Agriculture & forestry machinery	3.67	0.87	0.76	0.75	1.02
Domestic appliances	0.88	0.88	1.19	0.63	1.01
Office machinery	1.22	1.31	0.98	0.66	1.13
Electric motors, generators	0.90	4.79	1.63	0.14	1.02
Electric equipment	1.26	1.42	1.34	0.60	1.00
Electronic valves	2.66	1.47	1.60	0.26	1.26
Television & radio transmitters	1.27	0.97	2.95	1.05	1.06
Television & radio receivers	6.20	1.39	1.19	1.16	1.21
Medical & surgical equipment	1.27	1.54	1.14	4.04	1.04
Instruments	1.27	0.65	0.94	0.15	1.06
Motor vehicles	1.37	0.71	1.11	1.45	1.15
Motor vehicle parts	0.91	1.23	1.08	0.06	1.01
Ships, building & repairing	0.93	0.52	1.77	2.52	1.06
Railway & tramway rolling stock	1.02	11.33	0.69	1.01	0.76
Aircraft & spacecraft	1.69	0.87	1.36	0.90	1.03
Furniture	0.87	1.45	0.63	3.40	0.99
Mean *	1.87	1.62	1.31	2.52	1.02
Standard error	1.27	1.64	0.72	3.00	0.10

Notes: (1) Data source: Fame database; (2) All ratios from my own calculation; (3)\* Mean excluding two extreme values, the maximum and the minimum for all columns.



happens in electric valves, and the smallest gap is 0.76, which happens in the railway & tramway rolling stock sector.

The UK pharmaceutical and motor industries deserve more examination. The former is usually described as one of the most successful indigenous sectors and the latter the one characterised by significant foreign involvement. Columns 3, 4 and 5 indicate that the relative success of the UK pharmaceutical sector is largely attributed to the use of more non-physical capital, especially intangible assets, relative to their foreign counterparts. The foreign/UK ratios for intangible assets and human capital in this particular sector are 0.58 and 0.95 respectively far below the corresponding industry averages (intangible assets 2.52 and human capital 1.31). In contrast, foreign owned firms use significantly more physical capital, with a foreign/UK ratio of 8.01, far bigger than the average of 1.62. As a result, although foreign owned firms still enjoy relatively higher productivity, the gap ratio (1.25) is far below the average of 1.87 for all industries. In contrast, in the motor vehicle industry, which has one of the highest shares of foreign ownership in the United Kingdom, foreign owned firms obviously use more intangible assets, whereas UK owned firms use more physical capital. The smaller productivity gap in this industry, which is similar to the gap in pharmaceuticals, however, could be attributed to intra-industry spillover effects associated with the large presence of foreign owned companies in the sector. Spillover effects may play a role in raising the level of productivity of UK locally-owned companies.

Competition effects between foreign and locally owned firms are more reasonable within a small range of productivity and factor inputs differences. Extremely large productivity gaps would not lead to any continual interactions between the two types of firms. One can not imagine any tough competitive pressure and threats from a local electronics company in Somalia on an IBM subsidiary there, as the level of productivity of the former could be two-digits higher than the latter. In contrast to our case where the host is a developed country and the productivity and factor inputs gaps ranges between 1.02 and 2.52 on average, competition may be expected to be two-ways and very tough. So the Kokko's identification of competition-related spillovers may be more relevant on this occasion.

### **5.3.2 Models**

While the traditional Caves-type model captures the impact of most of the important variables, it does not account for the possibility of bi-directional spillovers highlighted in the recent literature. These bi-directional effects may be important given our study of a developed economy – the UK. They are cumulative when there are simultaneous interactions between foreign and local firms. Thus capturing these interactive relationships is equivalent to test whether or not the productivity of foreign and UK locally owned firms is jointly determined. This implies that a simultaneous model is necessary for the particular data set we are working with. Thus we follow Kokko (1996) and introduce a simple simultaneous equation system.

In our case, the system consists of two equations. In the first equation, labour productivity is measured by value added per worker in UK locally-owned firms (LPD) in an industry, and is influenced by the following variables: (1) value added in

foreign-owned firms (LPF); (2) physical capital intensity in UK-owned firms (CID), which is normally measured by a capital labour ratio indicating an average level of physical capital stock per capita; (3) human capital in UK-owned firms (HCD); (4) intangible assets per worker in UK-owned firms (IAD); (5) the industry concentration ratio (CR); (6) the presence of multinational firms or foreign presence (FP); (7) the average size of UK-owned firms in the particular industry (SIZED); and (8) the technology gap (GAP) between foreign and UK-owned firms. Similarly the labour productivity in foreign owned firms (VAF) is assumed to be influenced by the following variables: (1) value added per employee in UK-owned firms (LPD); (2) physical capital intensity in foreign-owned firms (CIF); (3) human capital in foreign-owned firms (HCF); (4) intangible assets per capita in foreign-owned firms (IAF); (5) the industry concentration ratio (CR); (6) the average size of foreign-owned firms (SIZEF); (7) the technology gap (GAP) between foreign and UK-owned firms.

Adopting the main features of the statistical model used to test spillovers in Chapter 4, we have a simple system illustrated by equations (5.1) and (5.2) below.

$$(LPD)_{it} = (CID)_{it}^{a_1} (HCD)_{it}^{a_2} (IAD)_{it}^{a_3} (SIZED)_{it}^{a_4} (CR)_{it}^{a_5} (FP)_{it}^{a_6} (GAP)_{it}^{a_7} (LPF)_{it}^{a_8} e^{\phi_{it}} \quad (5.1)$$

$$(LPF)_{it} = (CIF)_{it}^{b_1} (HCF)_{it}^{b_2} (IAF)_{it}^{b_3} (SIZEF)_{it}^{b_4} (CR)_{it}^{b_5} (GAP)_{it}^{b_6} (LPD)_{it}^{b_7} e^{\varphi_{it}} \quad (5.2)$$

Applying a logarithmic transformation to equation (5.1) and (5.2), we arrive at the linear regression model shown in (5.3) and (5.4) below:

$$(lpd)_{it} = a_1(cid)_{it} + a_2(hcd)_{it} + a_3(iad)_{it} + a_4(sized)_{it} + a_5(cr)_{it} + a_6(fp)_{it} + a_7(gap)_{it} + a_8(lp)_{it} + \phi_{it} \quad (5.3)$$

and

$$(lpf)_{it} = b_1(cif)_{it} + b_2(hcf)_{it} + b_3(iaf)_{it} + b_4(sizf)_{it} + b_5(cr)_{it} + b_6(gap)_{it} + b_7(lpd)_{it} + \varphi_{it} \quad (5.4)$$

Positive relationships are expected between the dependent variable and all explanatory variables except for the concentration ratio and technology gap whose coefficients may have a positive or negative sign. Given the fact that  $cr$ ,  $fp$  and  $gap$  are defined for industry totals (rather than for foreign and local firms separately), the signs for these variables should be interpreted cautiously. Equation (5.3) is equivalent to equation (4.2) except for the addition of the variable  $vaf$ , representing the labour productivity of foreign owned firms in the industry. This variable, as discussed in the previous section, is designed to capture the impact associated with competitive effects of foreign rivalry. In equation (5.3), since spillovers are basically the endogenous outcomes of the interactions between foreign and UK-owned firms, the productivity of UK-owned firms ( $lpd$ ) is influenced by the productivity of foreign-owned firms ( $lpf$ ) as well as other variables.

We are particularly interested in the signs of the coefficients on  $fp$  and  $lpf$  in equation (5.3) and  $lpd$  in equation (5.4). As explained in the previous chapter, if spillovers take place, foreign presence should have a significant positive effect on labour productivity in locally-owned firms. Kokko's (1996) interpretation is that a positive  $a_6$  implies that the very presence of multinational corporations leads to positive externalities via contagion and demonstration effects. A positive  $a_8$  ( $b_7$ ) would suggest that spillovers from the competition between foreign and UK-owned firms raises the productivity in foreign (UK-owned) firms.

The sign of variable *gap* in equation (5.3) could be either positive or negative, as discussed in Chapter 4. The benefit of learning from MNE affiliates can be realized in local firms only when the technology gap is within a relatively small range such that technological interaction between the two groups exists. As for the sign of *gap* in equation (5.4), one would normally expect a positive relationship between the technological gap and the productivity in foreign-owned firms. When the technology gap is large, the locally owned firms are not able to benefit fully from spillover effects and they will be placed at an obvious disadvantage in the competition. In contrast, foreign firms with technical advantage and therefore with lower marginal costs will have an incentive to increase production relative to local firms and achieve higher productivity. To some extent, the increase in productivity in foreign owned firms due to large technology gap can be only achieved by the reduction of productivity of domestically owned firms. This means that when the technology gap is large, competition increases foreign firms' productivity.

### 5.3.3 Methodology

To estimate the simultaneous equations (5.3) and (5.4), we use the method of two-stage least square (2SLS). If simultaneous interactions take place, the 2SLS estimates are more efficient and consistent than the corresponding OLS estimates.

Before moving to the estimations, however, it is useful to justify our use of simultaneity model for the particular data set. The reason is that the simultaneity of the present model depends on the existence of competition between locally owned firms and MNE affiliates. However, the efficiency of using multi-equation estimations should be low if foreign subsidiaries in some industries in our sample operate in “enclaves”, in isolation from local competition. A test of endogeneity is equivalent to

a test as to whether there are interactions between the two groups of firms, as we claimed above. The test for endogeneity we use here follows Geroski (1982), who argues that two equations, such as (5.3) and (5.4) above, are likely to be simultaneously determined if the residual of the reduced form estimates of equation (5.4) has a significant impact on the dependent variable in equation (5.3). In our case, we test for the endogeneity of  $lpf$  by estimating the following equation:

$$(lpd)_{it} = a_1(cid)_{it} + a_2(hcd)_{it} + a_3(iad)_{it} + a_4(sized)_{it} + a_5(cr)_{it} + a_6(fp)_{it} + a_7(gap)_{it} + a_8(lpf)_{it} + \lambda R + u_{it} \quad (5.5)$$

where:  $R$  is the residual from the reduced form of the OLS estimate of  $lpf$  or equation (5.4). If  $\lambda$  is statistically different from zero, then  $lpf$  is endogenous and the use of a simultaneous equation system is justified. If  $\lambda$  is not statistically significant, then  $lpf$  can be modelled as an exogenous variable and there is no need for a simultaneous equation system.

## 5.4 Empirical results

The estimation of equation (5.5) shows that  $\lambda$  is statistically different from zero at the 1% level. This suggests that the  $lpf$  variable (productivity in foreign-owned firms) is endogenous, justifying the estimation of simultaneous equations (5.3) and (5.4). The results from the two-stage least square regression are set out in Table 5.2.

Column (1) in the Table 5.2 presents the result from the estimation of equation (5.3), where the dependent variable is labour productivity in UK-owned firms. The estimates are based on the entire sample of 48 industries for the period 1991-1995.

As can be seen, 2SLS method yields the expected positive coefficients for all variables except *gap*.

**Table 5.2**  
**Results for Simultaneous Equations, 2SLS**

	(1) lpd		(2) lpf
lpf	0.3971 (5.299)***	lpd	0.9890 (8.719)***
cid	0.3704 (3.625)***	cif	-0.1780 (1.319)
hcd	0.1050 (1.658)*	hcf	0.1805 (3.260)***
iad	0.0018 (0.105)	iaf	0.0003 (0.018)
cr	0.0090 (0.138)	cr	0.0319 (0.541)
fp	0.0627 (2.434)**		--
size	0.0141 (0.411)	size	-0.0180 (-0.765)
gap	-0.7111 (-13.659)***	gap	0.7290 (14.209)***
Constant	0.2878 (0.879)	Constant	0.3480 (1.416)
$\overline{R^2}$	0.5227	$\overline{R^2}$	0.6450
NT	240	NT	240

Notes: (1) Figures in parentheses are t statistics (two-tailed tests);  
(2) \*, \*\*, and \*\*\* denote significance at the 10%, 5% and 1% levels respectively.

It is noteworthy that the coefficients for foreign presence and labour productivity in foreign-owned firms are both positive and significant. This suggests that technology spillovers to UK-owned firms be attributed not only to foreign presence but also to the level of productivity in foreign owned firms. The latter is effected through interactions or competition between the two types of firms.

The significant negative coefficient for the technology gap and positive coefficient for human capital are consistent with the findings from the estimations of the single equations in chapter 4. This again supports the hypothesis that a firm's capability to absorb foreign technologies depends on its existing level of technological competence and on its learning efforts [Perez, 1997]. It is interesting to note that, in contrast with the single equation approach, intangible assets or the stock of knowledge in this simultaneous system do not seem to play a significant role in raising labour productivity. The competitive interaction between foreign and UK-owned firms is apparently more important. The insignificance of the concentration ratio and average firm size is again consistent with the estimations of single equation in Chapter 4, although the *size* variable has a positive sign here.

Moving to column (2) of the table, we have the regression estimates for equation (5.4), when the dependent variable is labour productivity in foreign-owned firms. Here the most important result is that the coefficient for labour productivity in domestic firms is positive and significant. This implies a reverse spillover effect from UK-owned firms to those that are foreign-owned. In contrast to the findings of Kokko (1996) who found that the reverse spillover effect on the whole was vague and restricted to a subgroup of firms, this finding appears to support our argument that spillover effects from local firms to foreign subsidiaries are more significant when the host is a developed economy. While the coefficient for capital intensity is negative and insignificant, the impact of human capital appears to be more significant and larger than in the case of local firms in column (1). It seems that physical capital is less important for foreign firms than for local firms. Instead, foreign firms use more human capital than their local counterparts. The *gap* variable, again, is statistically



significant, but is positive. This is consistent with our early assumption. In contrast to the relationship between the technology gap and productivity in locally-owned firms, where typically a large technology gap impedes the growth of productivity of local firms, a large technology gap allows MNEs to enjoy technological advantages, which is consistent with the conventional theory of multinational enterprises.

The findings above appear to be consistent with Kokko's (1996) argument that there is an independent “competitive effect” on the productivity of locally-owned firms even after demonstration and contagion spillovers from foreign presence have been accounted for. They also lend support to the hypothesis that the productivities of local and foreign firms are simultaneously determined. These results however need to be viewed with extreme caution. A cautious interpretation is warranted given that, in contrast to our single equation model, intangible assets, our measure of technological competence does not seem to play a significant role in raising productivity. While in theory contagion and competitive effects may be distinguished, this may be more difficult to accomplish empirically. In fact, Caves (1974) uses the productivity of foreign firms ( $lpf$ ) to capture inter-industry differences in technology and capital intensity, rather than competitive spillover effects. This may help explain the insignificance of  $iad$  variable. Also as Kokko (1996, p. 522) acknowledges, a more complete model might treat foreign presence itself as an endogenous variable, “since the productivities of foreign and local firms are likely to be important determinants of the degree of foreign penetration”.

## 5.5 Conclusions

The objective of this chapter is to examine intra-industry productivity spillovers generated from competition between foreign and UK owned firms in the

UK manufacturing sector using a recent panel data set. The results from the estimations of this simultaneous equation system support the hypothesis that the productivity of foreign and UK-owned firms is jointly determined. We follow Kokko (1996) in interpreting this as a consequence of competition. Spillovers occur in both directions when the host is a developed country. These competitive spillovers are in addition to those flowing to UK-owned firms from the very presence of multinational corporations via contagion and demonstration effects.

The study of spillovers from FDI in this chapter, together with the chapter 4, has a number of shortcomings. It is possible that significant foreign technology spillovers happen in certain industries without FDI being recorded. International technology spillovers may occur as a result of strategic alliances between locally-owned firms and foreign firm. Also outward FDI may affect UK-owned firms' degree of interaction with foreign-owned affiliates in the UK. These two issues are not examined in this dissertation. Another shortcoming stems from the measurement of the technology gap. What appears as a large gap may actually be due to the heterogeneous activities of foreign and UK-owned firms classified to the same broad industry. Foreign firms may cater for the premium segments of markets while locally owned firms concentrate on standardised segments. While beyond the scope of this particular paper, the characteristics of industries displaying large technology gaps needs to be further investigated.

Despite its shortcomings, this study contributes to the empirical evidence on spillover effects in situations where the host is a developed country. One possible policy development from the results of this chapter concerns the encouragement of competition between the two types of firms. By doing so more spillovers can be

generated. One efficient way to do this is to encourage further integration between foreign investors and local firms, for example by linking local R&D institutes with FDI activities. In addition, since large technology gaps impede competition, given the technology gap observed in this study, it is also important to ensure that local firms especially those of low technological capability in the sectors where there is large foreign presence invest in R&D and/or human capital.

The productivity of UK locally owned firms appears to have been improved due to the existence of technology transfer and spillover effects associated with the operation of multinational subsidiaries. The next two chapters focus on comparison of economic performance between foreign and UK locally owned firms.

## **CHAPTER 6**

### **FACTOR DIFFERENCES, SPILLOVERS AND RELATIVE PRODUCTIVITY LEVELS OF FOREIGN SUBSIDIARIES**

#### **6.1 Introduction**

The 1980s saw a rapid growth in output per worker and total factor productivity in many sectors of the UK economy, both relative to the previous decade and relative to the US<sup>10</sup>. Many alternative theoretical and empirical explanations have been offered. This period of productivity growth coincided with many changes to the UK economy - the weakening of labour unions, rapid shakeouts of firms in the early 1980s recession, computerisation and increases in the quality of the labour force. It has also been noted that rapid productivity growth coincided with an increase in the inward flow of foreign direct investment (FDI). From the early literature of Vernon (1966), Dunning (1977) and Caves (1974) it has been suggested that multinational firms are more productive than average and are concentrated in the knowledge-intensive industries. This suggests that an increase in the presence of multinationals in the UK may have played a role in increasing productivity levels in UK industry, as higher productivity foreign-owned production replaced lower productivity domestic production. As discussed in previous chapters, the entry of multinational firms may also affect productivity levels in other ways through technology spillovers or through increasing the level of competition in the market.

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<sup>10</sup> See O'Mahony (1998), Oulton (1998), Cameron, Proudman and Redding (1998), and Dougherty and Jorgenson (1997) and Ark, V(1996).

Foreign-owned subsidiaries (FOSs) should outperform domestically owned firms (DOEs). In the traditional theory of FDI, this superior performance is related to their parent firms. The dominant theme in FDI theory is that multinationals are firms that have developed ownership advantages, represented mainly by knowledge-based assets. The use of these assets in overseas subsidiaries is assumed to lead to greater performance of foreign firms than their host country counterparts. The better performance of foreign subsidiaries relates also to other efficiency-generating competence variables. In fact, it is, among the other things, the differences in the production functions or in factor proportions that make the differential.

Given the superior productivity of the FOSs, however, domestically owned firms might benefit from the presence of foreign firms. Early chapters of this thesis show that DOEs which are in industries with strong foreign presence are more efficient than other firms due to spillovers through “demonstration” and “contagion” effects. Domestic-owned firms that are exposed to the full blast of foreign competition, face a much more hostile environment than other firms. This means that inefficiencies cannot be tolerated and firms must compete or die. Positive external effects may also come from foreign human capital formation, which raises the productivity of all workers in an industry. Workers employed by foreign firms or participating in joint ventures may accumulate knowledge that is valued outside the firm. As experienced workers leave the foreign firms, this human capital becomes available to domestic firms, raising their measured productivity. In fact, Dunning (1993) and Blomstrom (1989) show that the presence of FOSs in a given industry has been positively associated with the labour productivity of that industry. Other studies (Caves, 1974; Globerman, 1979; Blomstrom, 1989; Blomstrom and Wolff, 1994 and

Kokko, 1992) and findings in earlier chapters, find that a foreign presence helps domestic firms achieve higher levels of productivity. It is therefore assumed in this study that the presence of spillover effects may raise the labour productivity of UK owned firms and thus reduce the observed productivity gap with their foreign counterparts.

However, any spillover gains in productivity resulting from an increase in foreign employment, made by the domestic producers, may be not enough to alleviate their competitive disadvantage compared with the inward investors (Driffield, 1999). As discussed in the previous chapters, foreign presence can even reduce the productivity of domestically owned firms, particularly in the short run (see for example, Young, *et al*, 1994 and Aitken and Harrison, 1999). In fact, Aitken and Harrison (1999) found that increases in foreign ownership negatively affect the productivity of wholly domestically owned firms in the same industry in Venezuela.

This chapter investigates whether the stylised fact that multinational firms are more productive than domestic firms is borne out empirically. While quantifying factors that are likely to be important in explaining the inferior performance of indigenous firms, special attention is paid to the relationships between the productivity gap and spillover effects, and the productivity gap and wages gap. A general descriptive analysis of the differences between all domestic and foreign-owned production establishments in the UK is given and a detailed econometric analysis is carried out.

A feature of this chapter is that it addresses concerns about the bi-directionality between foreign ownership and industrial productivity by using firm level data, while also that holding industry influences constant through the use of dummy variables. This chapter also represents a unique study in employing a comprehensive dataset of individual firms of various sizes over several years, which enables us to compare explicitly the performance of foreign and domestic firms by sector. In contrast, a major criticism of many of the earlier studies of the performance of firms is that they have predominantly been concerned with large firms. This is likely to give rise to severe sample selection problems which leads to distortions in the comparisons of performance. In addition, as compared to a single cross-section or a time series, the use of panel data allows us to control for temporal persistent differences among firms that in many instances may bias estimates obtained from cross-sections.

Attempts are therefore made in this chapter to break new ground in four major areas. First, we provide a comprehensive study on the relative economic performance of foreign subsidiaries in the United Kingdom, which is an important issue given the large presence of foreign investment in the UK. Second, the study attempts to use ownership advantage theory to explain the superior performance of foreign owned firms. Third, it compares differences in labour productivity to differences in total factor productivity and capital productivity. Fourthly, it addresses the role of spillover effects in reducing the productivity gap.

Section 6.2 reviews the literature. Section 6.3 describes the data and 6.4 presents the empirical models employed. Section 6.5 analyses the factors accounting

for the productivity gap between foreign and UK owned firms. The empirical relationships between the productivity gap and spillover effects and the relationship between productivity gap and wages gap are discussed in sections 6.6 and 6.7 respectively. The final section concludes the chapter and offers policy recommendations.

## **6.2 Literature review**

Host country perceptions of the benefits of foreign participation, especially the provision of several indirect inputs is consistent with an industrial approach to foreign direct investment. This approach argues that the ability of a multinational firm to compete in a foreign environment, where there are added costs of doing business, must arise due to the ownership of some firm-specific advantages. These productive advantages, usually intangible, may take the form of management and marketing skills, knowledge of a particular production process or the possession of trademarks and patents. Broadly these proprietary assets may be classified as the knowledge capital (see Markusen, 1995) of a multinational firm enabling it to compete in the domestic market. From the perspective of a host country, potential access to these scarce inputs, through training and the local diffusion of knowledge and technology, is a compelling reason to encourage foreign participation.

The potential role of the multinational corporation in spreading knowledge and consequently encouraging growth also finds support in the endogenous growth and new trade literature which focuses on the role of multinational firms in transferring technology from the frontier to technologically more backward economies. A large theoretical literature has evolved that attempts to explain the determinants and effects



of foreign investment on productivity and growth. For example, Romer (1993) argues that in addition to the lack of traditional inputs such as capital, developing countries may suffer from an “idea gap”. While there are several ways in which this ideas gap may be bridged, Romer argues that the quickest and most reliable way to bridge the ideas handicap that hinders growth is by creating a domestic economic environment conducive to the flow of foreign direct investment.

Despite the importance attributed to these additional productive inputs, their intangible nature makes it difficult to measure whether foreign participation does indeed lead to their provision. Despite several case studies and surveys highlighting the manner in which foreign firm presence has improved domestic firm performance<sup>11</sup> the quantitative impact of foreign firms in spreading knowledge is hard to ascertain. In fact, the picture emerging from more detailed and quantitative studies is not quite clear. As discussed in earlier chapters, there are conflicting findings from existing empirical studies with respect to the significance of the impact of the presence of foreign-owned firms on the domestic industries. In another attempt at gauging the flow of productive knowledge, Aitken et al. (1996) examines the impact of foreign presence on industry wages. Using data from Mexico, Venezuela and the United States they find support from the data that foreign firms transfer intangible assets to the host country but consistent with their earlier work these effects are restricted to foreign firms with no spillovers to the domestic industry.

Empirical work associated with endogenous growth and new trade theories, largely at the aggregate level, has identified correlations between the openness of

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<sup>11</sup> For references and a survey of the technology and export marketing benefits conferred by foreign corporations see Helleiner (1989).

economy and growth in productivity or export performance<sup>12</sup>. An alternative explanation is offered by Nickell (1995) who argues that productivity increases in the UK over the 1980s were due more to management innovation and the reorganization of production than to a surge in the rate of technological or scientific advance<sup>13</sup>. In contrast, Dougherty and Jorgenson (1997) argue that differences in output growth across the G7 countries can be almost entirely explained by differences in the levels and growth rates of investment in physical, human and knowledge capital.

There is a large literature focusing on the relative performance of foreign subsidiaries of developed country origins over indigenous firms in developing countries (see, for example, Balasubramanyam,1984; Blomstrom,1989; Newfarmer and Marsh,1981, and Haddad and Harrison,1993). While some tend to conclude that foreign owned firms are outperformed by their local competitors, the empirical evidence is still basically mixed. When the host is a developed country, one would reasonably assume a smaller performance gap. This is because relatively small differences between the home and host country in the factor inputs and market conditions, which affect economic performance, is expected. Covari and Wisner (1991) and Globerman, et al (1994) have identified higher average productivity levels of foreign affiliates compared with those of Canadian-owned firms. However, in the United States, FOSs are not found to enjoy monopolistic advantages over U.S. local competitors (Ajami and David, 1981 and Franco, 1976), and they are even less profitable than DOEs ( Kim and Lyn, 1990).

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<sup>12</sup> Studies using labour productivity are Bernard and Jones (1996a,b) and Barrell and Pain (1997); a study focusing total factor productivity is Cameron, Proudman and Redding (1998); studies using micro-data are Blomstrom and Persson (1983) and globerman (1979).

<sup>13</sup> See also Layard and Nickell (1989), Bean and Symons (1989) and Bean and Crafts (1995).

It is well known that UK locally owned firms do not perform as well as foreign subsidiaries in manufacturing industry. Barrell and Pain (1997) estimate the labour productivity of US manufacturing affiliates in the United Kingdom to be around one-third higher than UK companies on average in 1994. This study is based on data for aggregate manufacturing; the impacts of the industrial distribution of FOSs are not controlled for. Davis and Lyons (1991) find that FOSs operating in the UK had an average productivity advantage of 20 percent over their domestic counterparts. Further they find that no more than half of this disparity can be explained by the relative concentration of foreign-owned firms in high productivity sectors. What is not so clear from the study is the source of the foreign-owned firms' advantage. As admitted by the authors, however, the observed labour productivity gap might equally be due to differentials in labour skills, capital inputs, or the size of the firms as noted in the literature.

Globerman (1979) noted the possible impact of spillover effects associated with foreign ownership on the magnitude of productivity differences between foreign and domestic firms. According to Globerman, the analysis of the precise determinants of productivity differentials between ownership groups could provide some insight into whether external economic benefits are associated with foreign ownership. Globerman finds that differences in labour productivity among Canadian owned plants derive in part from spillover efficiency benefits associated with foreign direct investment.

Griffith (1999a/b) addresses the question of whether multinational firms played a role in United Kingdom productivity growth over the period between 1980-

92 by looking at whether foreign owned establishments have higher productivity levels than domestic-owned establishments and whether an increase in the proportion of foreign-owned establishments accounts for some of the increase in the average level of productivity. Using data from the Annual Census of Production (ACOP) or Annual Business Inquiry (ABI) Respondents Database (ARD) which is held at the ONS office in Newport, he finds that across all manufacturing establishments foreign-owned establishments are larger and producing more per worker than domestically-owned establishments.

More specifically, Griffith (1999a) examines the productivity differences between foreign and UK owned firms in the car industry. This industry is chosen because it has one of the highest shares of foreign ownership in the United Kingdom, with on average only less than half of output coming from domestic-owned establishments. This industry has seen an increase in foreign ownership from around 40 per cent in 1980 to near 70 per cent in 1995. Griffith looks at changes in the relative levels of productivity between the two groups of establishments between 1980-1992. The differences between the two groups are pronounced. In 1980 foreign-owned establishments were over six times as large on average as domestically-owned establishments and produced almost five times as much in terms of value-added. Average output per worker was similar across the two groups in 1980, while value-added per worker was slightly higher in domestic-owned establishments. By 1992 there were over twice as many foreign-owned establishments as in 1980 and fewer were domestically-owned. Foreign-owned firms produced 36 per cent higher value-added than domestically-owned establishments (down from nearly five times as much in 1980). However, output per employee was 50 per cent higher in foreign-owned

than in domestic-owned establishments. It appears that as foreign investors increase their presence, they become more productive than their domestic counterparts, which pushes up the productivity level of the entire industry.

It is difficult to compare the various empirical studies. The studies show differences with respect to the level of data used, the countries and industries compared and the time periods involved. Also the procedures for measuring the various factor-intensities differ. However, many of the authors point out that observations of higher average productivity in foreign-owned firms may simply reflect the fact that these firms are clustered in the industries where above-average productivity is usually enjoyed, rather than any pure ownership effects.

## **6.3 The Data and analytical frame work**

### **6.3.1 The sample**

The data used in this Chapter are from the FAME database. The sample of manufacturing firms was drawn by requiring that each firm report sufficient data in all the five years over 1990-96 period. Data for 1990 and 1991 are not included in our sample due to questionable entries for a number of companies. As a result, this study uses a panel dataset, which contains 14,233 firms of foreign and domestic origin across 14 sub-manufacturing industries-the broadest classification of Standard Industrial Classification (SIC) for the period 1992-96.

The data are broken down by ownership. As defined in the FAME, FOSs are those where at least 50 percent of share capital is in foreign ownership. The sample contains 14,233 firms, which account for approximately 26 percent of the total

number of manufacturing firms in the database. There are 4,267 FOSs and 9,966 DOEs, which represent about 30 of the total number of foreign firms and about 23 percent of the total number of UK-owned firms in the database respectively. Thus the sample is fairly representative of UK manufacturing industry.

A simple sample analysis is given in Table 6.1. As shown in this table, about 69% the FOS sample is concentrated in five industries: paper, chemical products, basic metals, machinery and equipment, and electronics and optical products. The proportion of DOEs in these five industries is 62%. On the whole the industrial distribution of the FOS sample basically matches the distribution of UK locally-owned firms.

**Table 6.1**  
**An Overview of the Sample**

Industry		Number of firms					
		UK		Foreign		Total	
SIC	Name	Number	Per cent	Number	Per cent	Number	Per cent
DA	Food , beverage, and tobacco	805	8.1	280	6.6	1085	7.6
DB	Textile products	610	6.1	110	2.6	720	5.1
DC	Leather products	93	0.9	15	0.4	108	0.8
DD	Wood products	206	2.1	37	0.9	243	1.7
DE	Pulp, paper, publishing	1605	16.1	482	11.3	2087	14.7
DF	Coke, petroleum, and nuclear	41	0.4	46	1.1	87	0.6
DG	Chemical products	736	7.4	542	12.7	1287	9.0
DH	Rubber and plastic products	503	5.1	181	4.2	684	4.8
DI	Other non-metallic mineral products	293	2.9	108	2.5	401	2.8
DJ	Basic metals	1821	18.3	660	15.5	2481	17.4
DK	Machinery and equipment	710	7.1	453	10.6	1163	8.2
DL	Electrical and optical products	1292	12.9	808	18.9	2100	14.8
DM	Transport equipment	343	3.4	148	3.5	491	3.4
DN	Other	908	9.1	397	9.3	1305	9.2
Total manufacturing		9966	100.0	4267	100.0	14233	100.0

Notes: (1) Source: the author's owned calculation from the FAME database: (2) Foreign= Europe+US+Japan

### 6.3.2 Productivity and factor intensity ratios

#### *A factor proportion approach*

This study takes a factor proportion approach to analysing productivity differences. As noted earlier, we assume that differences in relative productivity performance across firms can arise in a number of ways with which resources are used. The simplest possibility is that adopted as a maintained hypothesis by the early neo-classical analyses of late Victorian Britain (McCloskey, 1970). It is supposed that any differences between labour productivity levels in Britain and foreign countries in a given industry arose from factor inputs, particularly in capital and material resources to labour ratios. Following this, in the case of comparison of FOSs and DOEs, we have for an industry:

$$LP_{foreign/uk} = f(CI_{foreign/uk}, MI_{foreign/uk}) \quad (6.1)$$

where  $LP$  is labour productivity, measured as value-added per employee, and  $CI$  and  $MI$  are the corresponding capital and material input intensities.

A more sophisticated extension of this model would allow for variations in the use of technology ( $TEC$ ), human capital ( $HC$ ), and economies of scale ( $SIZE$ ). The augmented version of the first hypothesis is shown below:

$$LP_{foreign/uk} = f(CI_{foreign/uk}, MI_{foreign/uk}, TEC_{foreign/uk}, HC_{foreign/uk}, SIZE_{foreign/uk}) \quad (6.2)$$

Since reliable data on material inputs was not available, the effect of *MI* could not be estimated, causing an omitted variable problem. Equation (6.2) assumes that labour productivity differentials between FOSs and DOEs are largely explained by differences in relative factor proportions and economies of scale.

Positive relationships are expected between the dependent variable and all explanatory variables. Physical capital intensity (*CI*) is normally measured by a capital-labour ratio indicating an average level of physical capital stock per capita. Clearly the productivity of a given firm is an increasing function of physical capital per worker. The average firm size (*SIZE*) variable represents economies of scale and it is usually assumed to be positively related to labour productivity in the literature. The role of the size effect is particularly stressed by Blomstrom (1985) who shows that most of the differences in productivity are explained by differences in size between the FOSs and DOEs.

A variable, which is unique to this study, is *TEC*. This variable is proxied by intangible assets per worker (*IA*). A positive relationship is expected between this independent variable and the labour productivity. Given that ownership advantages are mainly embodied in intangible assets, one of the priorities of this chapter is to examine whether the FOSs' productivity advantage is associated with their superiority of technology.

Another variable of interest is human capital (*HC*). A higher value of human capital may be seen as evidence of higher learning efforts, or a larger effective labour force. Theoretical models of economic growth such as Lucas (1988), whose engine of



growth is unlimited accumulation of human capital, emphasise the effects of differences in the "stock of knowledge" which is not specific to any individual. In these models an additional term measuring externalities from human capital accumulation is included in the production function so that differences in skills have a greater relative emphasis than allowed for under the growth accounting method.

In order to get closer to a measure of relative performance, one could also attempt to estimate total factor productivity ( $TFP$ ). The ratio between FOSs and DOEs can be estimated on the basis of Solow's traditional specification of the simple Cobb-Douglas production function in logarithmic form. By allocating weights to the inputs of labour and capital, one can derive the proxy for total factor productivity.

$$\ln TFP_{foreign} / TFP_{uk} = \ln V_{foreign} / V_{uk} - (\alpha * \ln L_{foreign} / L_{uk}) - ((\alpha - 1) * \ln C_{foreign} / C_{uk}) \quad (6.3)$$

where:  $TFP$  is total factor productivity, and is measured as real value added (  $V$  ) per composite unit of labour and capital. Other variables are as usually defined.

#### *A preliminary analysis*

Much can be learned from comparing the productivity levels and input intensities of foreign-owned firms in the UK to their domestic counterparts. Following equation (6.2) and (6.3), table 6.2 shows the ratio of the mean value of output and inputs in foreign-owned firms to the mean value in domestic-owned firms for 14 branches of manufacturing sector over the period 1992-96. Clearly the FOSs enjoy higher labour productivity in all industries except transport equipment. The gap ranges from 0.91 in the transport equipment sector where UK firms perform better

than foreign firms, to 2.05 in the leather sector. The average labour productivity gap is 1.28, which is slightly smaller than the estimate of Hubert and Pain (1999), which is 1.47. Large gaps also occur in coke and the electrical sectors. The large standard deviation of intangible assets per worker is caused by the generally poor data quality of intangible assets. The large standard deviation of human capital may be partly due to our approach where we use the “residual” to proxy this variable.

**Table 6.2**

**Comparative Levels of Productivity and Input Intensities\*(Foreign/UK)**

Industry	Variables								
SIC	LP	TFP	CP	CI	IA	HC	SIZE	FPEM	WAGE
DA	1.19	0.88	0.87	1.35	2.17	0.34	0.90	0.10	1.31
DB	1.25	0.90	0.74	1.72	2.56	1.04	1.39	0.06	1.03
DC	2.05	1.02	0.76	2.67	0.04	0.51	1.24	0.05	1.34
DD	1.18	0.81	0.70	1.74	2.33	0.23	1.57	0.08	1.19
DE	1.25	1.19	1.24	0.98	1.11	1.17	1.76	0.35	1.12
DF	2.04	1.08	0.91	2.43	2.19	0.20	0.56	0.21	1.57
DG	1.06	1.09	1.15	0.92	1.94	1.14	0.93	0.21	1.04
DH	1.17	0.96	0.94	1.21	3.37	1.45	2.27	0.26	1.17
DI	1.05	0.88	0.84	1.24	4.56	1.32	1.53	0.10	1.13
DJ	1.03	0.90	0.84	1.21	1.16	2.21	1.66	0.16	1.04
DK	1.16	1.11	1.20	0.95	1.99	17.77	1.02	0.27	1.14
DL	1.29	1.14	1.13	1.14	1.15	1.71	1.49	0.20	1.11
DM	0.91	0.97	1.14	0.79	1.37	2.53	1.70	0.19	1.18
DN	1.22	0.07	0.61	2.20	0.15	0.34	2.07	0.22	1.25
Mean	<b>1.28</b>	<b>0.93</b>	<b>0.93</b>	<b>1.47</b>	<b>1.86</b>	<b>2.28</b>	<b>1.39</b>	<b>0.18</b>	<b>1.19</b>
Standard deviation	<b>0.34</b>	<b>0.27</b>	<b>0.20</b>	<b>0.58</b>	<b>1.19</b>	<b>4.52</b>	<b>0.43</b>	<b>0.09</b>	<b>0.14</b>

Notes: (1) Source: the author's own calculation from FAME database; (2) All the figures except FPEM are calculated as the average ratios of 'FOSs/DOEs' over 1992-96; (3) *CP* is capital productivity, and it is measured as the ratio of value-added to the stock of physical capital.

An interesting finding from table 6.2 is that higher relative foreign labour productivity is not accompanied by higher relative foreign total factor productivity.

The UK firms perform better in terms of *TFP* on average<sup>14</sup>. This is because UK firms enjoy higher relative capital productivity as shown in the table.

The relatively lower *TFP* in the FOSs coincides with higher relative factor input proportions of FOSs. This suggests that the UK -owned firms' superior *TFP* cannot be explained by factor input differences. The following analysis focuses therefore only on labour productivity.

## 6.4 Empirical models

As mentioned earlier, the productivity performance of firms depends on what industry the firm is in and whether the firm is domestically or foreign owned. In equation (6.4), a set of industry dummy variables is used taking “food products, beverages, and tobacco” as the base industry. When using ownership dummy variables, UK ownership is used as the constant. Thus we have:

$$LP_{ij} = \alpha + \sum_{k=1}^{13} \gamma_{kij} I_{kij} + \delta_{ij} N_{ij} + \varepsilon_i \quad (6.4)$$

where  $\alpha$  is the intercept that includes the average effect of a UK establishment in the food product, beverages and tobacco industry. The dummy variable,  $I_{kij}$  is equal to one if firm  $i$  is in the industry  $k$  and zero otherwise, and  $N_{ij}$  is a dummy variable equal to one if establishment  $i$  is of foreign nationality and zero otherwise. In our sample,  $i = 14,233$  firms covering  $k = 14$  industries over the years 1992-1996 ( $j = 5$ ).

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<sup>14</sup> A similar and interesting finding by Mary O'Mahony (1998) is that Britain had a multifactor productivity advantage over Germany in the late 1980s. In contrast, it is well known that Germany had an advantage over the UK in terms of labour productivity.

Assuming that some of the home country differences in productivity can be attributed to factor proportion differences in capital intensity ( $CI$ ), intangible assets per capita ( $IA$ ), human capital ( $HC$ ) and the size of firms ( $SIZE$ ), the influences of these factors are separated from other “nationality” specific characteristics:

$$LP_{ij} = \alpha + \beta_1 CI_{ij} + \beta_2 IA_{ij} + \beta_3 HC_{ij} + \beta_4 SIZE_{ij} + \sum_{k=1}^{13} \gamma_{kij} I_{kij} + \delta_{ij} N_{ij} + \varepsilon_i \quad (6.5)$$

Following Kokko (1994), assuming also that DOEs benefit from the existence of spillover effects, one would anticipate a positive relationship between labour productivity in domestically owned firms and some measure of foreign ownership in an industry. This view of the spillover mechanism argues for the following equation:

$$LPD_{ij} = \alpha + \beta_1 CI_{ij} + \beta_2 IA_{ij} + \beta_3 HC_{ij} + \beta_4 SIZE_{ij} + \beta_5 FP_{ij} (FIA_{ij}) + \varepsilon_i \quad (6.6)$$

where,  $LPD$  is labour productivity in UK domestically owned firms;  $FP$  is the share of number of employees of FOSs in the total employment in the industry. Alternatively,  $FIA$  is the ratio of intangible assets of FOSs to the employment in DOEs in an industry. If spillovers take place, we would expect that  $FP$  variable has a positive significant impact on the productivity of domestic firms. The use of  $FIA$  is to examine whether the level of intangible assets in FOSs influences the level of productivity of DOEs through technology transfer or a demonstration effect. We expect that the levels of both  $FP$  and  $FIA$  are positively related to the level of productivity in DOEs and therefore negatively related to the productivity gap between the two groups of firms.

We then establish the link between the individual determinants of labour productivity and industry and nationality by estimating the following equations:

$$CI_{ij} = \alpha + \sum_{k=1}^{13} \gamma_{kij} I_{kij} + \delta_{ij} N_{ij} + \varepsilon_i \quad (6.7)$$

$$IA_{ij} = \alpha + \sum_{k=1}^{13} \gamma_{kij} I_{kij} + \delta_{ij} N_{ij} + \varepsilon_i \quad (6.8)$$

$$HC_{ij} = \alpha + \sum_{k=1}^{13} \gamma_{kij} I_{kij} + \delta_{ij} N_{ij} + \varepsilon_i \quad (6.9)$$

$$SIZE_{ij} = \alpha + \sum_{k=1}^{13} \gamma_{kij} I_{kij} + \delta_{ij} N_{ij} + \varepsilon_i \quad (6.10)$$

As discussed earlier, the  $LP_{ij}$  gap and  $TFP_{ij}$  gap between the two groups of firms are not of the same magnitude. This could be due to differences in capital efficiency, proxied by capital productivity ( $CP_{ij}$ ). Substituting  $CP_{ij}$  for  $LP_{ij}$  as the dependent variable in equation (6.4), the differential in capital productivity between the two groups is examined. Similarly, substituting average wages ( $W_{ij}$ ) for  $LP_{ij}$  as dependent variable in the equation (6.4) and (6.5), the differential in the level of wages between the two groups is investigated. It is possible that the presumed higher levels of labour productivity of FOSs are reflected in higher wages.

In equation (6.4)-(6.10), all variables are estimated in logarithmic form except the industry and ownership dummies. The log transformation reduces the influences of extreme observations that may be due to errors or anomalies in the data. Equations are estimated through pooled ordinary least squares (POLS).

## 6.5 The Productivity gap and factor proportion differences

Table 6.3 reports results obtained from estimating equation (6.4), (6.5) and (6.7)-(6.10). Equation (6.4) shows that labour productivity in FOSs is higher than in DOEs, holding industry influences constant. This is consistent with many previous studies in the same area. This also mirrors the fact that there is a significant productivity gap between Britain and other countries, notably the United States (see for example, Davies and Caves, 1987; Prais, 1981), the main player of inward FDI in the UK.

**Table 6.3**

### Regression Results: Factor Proportion and Productivity

Equations	Results
(6.4)	$LP_{ij} = 0.23N_{hij}$ $\bar{R}^2 = 0.69$ (7.28***)
(6.5)	$LP_{ij} = 0.34CI_{ij} + 0.34IA_{ij} + 0.63HC_{ij} + 0.02SIZE_{ij} + 0.03N_{ij}$ $\bar{R}^2 = 0.69$ (5.69***) (3.17***) (6.12***) (1.61*) (1.73*)
(6.7)	$CI_{ij} = 0.31N_{ij}$ $\bar{R}^2 = 0.89$ (8.38***)
(6.8)	$IA_{ij} = 0.50N_{ij}$ $\bar{R}^2 = 0.75$ (2.90***)
(6.9)	$HC_{ij} = 0.15N_{ij}$ $\bar{R}^2 = 0.49$ (6.33***)
(6.10)	$SIZE_{ij} = -0.22N_{ij}$ $\bar{R}^2 = 0.50$ (-1.29)
(6.4a)	$CP_{ij} = -0.09N_{ij}$ $\bar{R}^2 = 0.86$ (-2.71***)

Note: (1) \*, \*\*, and \*\*\* denote significance at 10%, 5% and 1% levels respectively; (2) Figures in the parentheses are *t* statistic; (3) For convenience of expression, industry dummy variable coefficients are suppressed.

In equation (6.5), all explanatory variables are added to equation (6.4). The result shows that greater capital intensity, intangible assets per worker, human capital, and size contribute to the value-added per employee in the expected way. All

variables except “size” are significant at the 0.01 level. However, when additional variables are added, the nationality variable ( $N_{ij}$ ) loses significance dropping from 0.01 to 0.10. This indicates that, even when conditioning factors are held constant, UK-owned firms are still less efficient than foreign subsidiaries. This is because the values of the conditioning independent variables themselves may indirectly reflect the influence of foreign ownership (Globerman, *et al*, 1994).

As discussed earlier, the labour productivity gap might result from the differences in factor proportions between the two groups of firms. This is tested by estimating equations (6.7)-(6.10), with the results shown in Table 6.3.

Equation (6.7) suggests that FOSs are more capital intensive when industry-related influences are held constant. This implies that capital per worker plays a role in explaining the observed labour productivity gap. The obvious question to ask is, if foreign-owned firms use high capital intensity to achieve high productivity, why don't the UK locally-owned firms do the same? A possible reason is that UK-owned companies may face a higher cost of capital than foreign-owned ones. Foreign companies are not presumably constrained to acquire funds for investment from the UK financial system, or at least not to the same extent as UK ones, so the deficiencies in the UK system may be hindering investment by UK companies. Foreign companies may also have a lower cost of internal funds (Miles, 1993). Another hypothesis is that foreign companies may be using superior technology and business methods that happen to be more intensive in both capital and skilled labour. The equation (6.10) shows that size is negatively related to the ownership variable, although not statistically significant.

From the perspective of FDI theory, the substantial productivity lead of foreign-owned companies shown by our results is in line with a large literature stressing the productive effects of foreign investment (e.g. Dunning, 1981 and Barrell and Pain, 1997). The relative poor labour productivity in the DOEs may be closely related to a failure to achieve a comparative technical advantage, as indicated in the equation (6.8). It is shown in this equation that FOSs have obvious advantages over DOEs in holding intangible assets. In fact, the average gap of intangible assets per capita are 1.86 (Table 6.2). Given that the “intangible hypothesis” is the most plausible and prominent explanation of foreign ownership in the received theory, foreign ownership may be able to exploit a larger R&D stock or knowledge base. This finding is consistent with many previous studies (see, e.g. Broadberry and Crafts, 1990, Ark, 1990a, and Carr, 1992), which claim that British firms have been less committed to R&D than their major international rivals. However, the intangible assets advantage held by foreign-owned firms should not be over-stressed particularly given that FDI in the UK is mainly involved in labour intensive activities (Barrell and Pain, 1997). As pointed out by the above same authors, in fact, the research intensity of affiliates in the UK, measured as R&D expenditure relative to sales, is below the European average, with the most research intensive affiliates being located within Germany, France, Belgium and Ireland.

It should be noted, however, that capital intensity itself is a proxy variable for technology intensity to the extent that technology is capital embodied. Therefore the results in equation (6.7) and (6.8) are theoretically consistent. It should also be pointed out that, separation of physical and human capital ignores the possible



interaction between these two types of capital. It is likely that more physical capital requires greater amounts of workforce skills in its operation.

Equation (6.9) shows that the substantial differential in the use of human capital could also be responsible for the observed productivity gap. In fact, the average gap of human capital is 2.28, as shown in the table 6.2. Research (Prais, 1981, Barnett, 1986, and Sanderson, 1988) shows that in recent years deficient education and training of workers on the shopfloor, from foremen downwards, has had a major impact on British productivity levels relative to those of foreign countries. This pattern of results is consistent with other studies that highlight both the higher level of technical and scientific skills in the workforce of FOSs (Mason et al, 1994, Ark, 1990a and Carr, 1992).

Equation (6.4a) shows that DOEs enjoy higher capital productivity than FOSs, which is consistent with the summary statistics in Table 6.2. This partly explains why UK indigenous firms have advantages over foreign affiliates in terms of total factor productivity.

## **6.6 The Productivity gap, spillover effects and the technology gap**

### **6.6.1 The Productivity gap and spillover effects**

While on the whole DOEs are not performing as well as their foreign counterparts, the labour productivity gap does vary across industries. The relatively smaller productivity gaps between the FOSs and DOEs in some industries can to some degree be attributed to spillover effects that arise purely from the presence of foreign owned firms. It can be predicted that the industries with a below-average

productivity gap are possibly those that benefit more from spillover effects. In fact, Davies and Caves (1987) explain why some British industries perform better than others relative to their American counterparts. They emphasise the influence of competitive forces in the form of foreign rivals in both home and export markets. In these contested markets, UK firms are under pressure to eliminate inefficiencies and increase their productivity.

Assuming that the magnitude of spillovers is negatively related to the productivity gap between the foreign and UK-owned firms, the fourteen industries are divided into a “large gap” group and a “small gap” group. Equation (6.6) is estimated for the two groups with results shown in Table 6.4. If spillovers take place, either the share of number of employees of FOSs in the total employment in the industry, *FPEM* or the ratio of intangible assets of FOSs to the employment in DOEs in an industry, *FIA*, or both should have a significant positive impact on labour productivity in DOEs.

**Table 6.4**  
**Spillovers Effects and The Productivity Gap**  
(Dependent variable: labour productivity in UK-owned firms, *LPD*)

Variables	Large Gap		Small Gap	
<i>CI</i>	0.04 (0.33)	0.18 (2.43***)	0.16 (2.31***)	0.02 (0.28)
<i>IA</i>	0.10 (4.47***)	0.07 (42.28***)	0.05 (3.66***)	-0.04 (-1.66)
<i>HC</i>	0.64 (4.42***)	0.58 (3.59***)	0.72 (4.88***)	-0.22 (-0.91)
<i>SIZE</i>	0.09 (1.14)	-0.03 (-0.43)	0.07 (2.52***)	0.02 (0.36)
<i>FP</i>	-0.22 (-0.53)		0.19 (3.77***)	
<i>FIA</i>		0.02 (0.50)		0.11 (5.88***)
	$\bar{R}^2 = 0.83$	$\bar{R}^2 = 0.65$	$\bar{R}^2 = 0.67$	$\bar{R}^2 = 0.79$

Note: (1) \*, \*\*, and \*\*\* denote significance at 10%, 5% and 1% levels respectively. (2) Figures in the Parentheses are *t* statistic.

Table 6.4 shows that the significance of both *FP* and *FIA* coincides with small productivity gap. *FP* is significant at 1 percent level when the productivity gap is small. This suggests that the extent to which FOSs generate spillovers and raise productivity levels among DOEs is negatively related to the technology gap. This finding is consistent with findings in earlier chapters. Large technology gap may indeed inhibit spillovers from FDI to local firms (Haddad and Harrison,1993). Significant *FIA* implies that intangible assets in foreign firms have a significant positive impact on the labour productivity of DOEs in the industries where the productivity gap is small through either technology transfer, or “demonstration effects”, or both. This finding appear to be consistent with the argument that the MNE transfer technology from parent firms to foreign subsidiaries and then host country firms learn from these subsidiaries. Empirically this finding is consistent with Davies and Lyons (1991) who find that innovative production and management techniques of FOSs appear to have been spread to many UK-owned companies and raised labour productivity of these locally-owned firms. The existence of this impact is positively related to the extent of technology transfer within the MNE, for which we found evidence for the case of Scotland in Chapter 3. This finding further confirms the significant positive link between intangible assets and productivity, for which evidence was found in Chapter 4 with a different database. In contrast, when the productivity gap is large, both *FP* and *FIA* have no significant impact on the productivity of DOEs.

### 6.6.2 Spillover effects and the technology gap

The extent to which spillovers reduce the productivity gap, may depend largely on the technological gap between the foreign subsidiaries and UK-owned firms. In Table 6.5, equation (6.6) is re-estimated, where the level of intangible assets per employee in UK indigenous firms in an industry is used as a proxy for the technological capabilities of UK-owned firms. This is in contrast to Kokko (1994) who uses average payments of patent fees in an industry. Intangible assets per capita is used as a criterion to divide local UK firms into two groups in each industry: one having a “high” level of innovative knowledge and hence a “good” capability of imitating or challenging foreign investors, and the other having a “low” level of knowledge and “weak” capability. It is expected that the higher the intangible assets per capita of indigenous firms, the more significant the impact of foreign firms on local productivity.

**Table 6.5**

**Spillover Effects and the Gap of Intangible Assets Per Capita**  
(Dependent variable: labour productivity in UK owned firms,  $LP_{uk}$ )

Variables	Low $IA$		High $IA$	
$CI$	0.29 (3.63***)	0.21 (2.75***)	-0.03 (-0.26)	0.29 (2.99***)
$IA$	0.10 (3.43***)	0.06 (2.12***)	0.08 (3.91***)	0.06 (2.99***)
$HC$	0.45 (2.48***)	0.61 (3.84***)	0.02 (3.97***)	0.26 (1.22*)
$SIZE$	-0.09 (-1.49)	-0.02 (-0.29)	0.16 (3.78***)	0.01 (0.16)
$FP$	-0.17 (-0.58)		0.85 (2.63***)	
$FIA$		0.03 (0.78)		0.01 (1.72*)
	$\bar{R}^2 = 0.56$	$\bar{R}^2 = 0.64$	$\bar{R}^2 = 0.84$	$\bar{R}^2 = 0.82$

Note: (1) \*, \*\*, and \*\*\* denote significance at 10%, 5% and 1% levels respectively. (2) Figures in the Parentheses are  $t$  statistic. (3) For convenience of exposition, industry dummy coefficients are suppressed.

Focusing on the coefficients of *FP* and *FIA* again in Table 6.5, when intangible assets per capita is low, i.e. the intangible assets gap is large and there are no spillovers generated. In contrast, when the gap is small, local productivity is significantly enhanced via spillover effects from foreign presence and higher level of foreign technology. This finding is consistent with Perez's proposition (1997) that a firm's capability to absorb foreign technology depends on its existing level of technological competence, and its learning efforts, and is also consistent with the empirical findings of Kokko (1994). Together with the results in Table 6.4, an interesting conclusion that can be drawn from this finding is that the productivity gap between foreign and the UK owned firms is a negative function of the technological capability of the UK indigenous firms. Here again the finding confirms the conclusions drawn in previous chapters.

## **6.7 Wages, wages spillovers and the productivity gap**

Taking a strictly neo-classical view, foreign direct investment arbitrages capital toward cheaper sites of production, where unit labour costs are an important determinant. Foreign investment attracted by lower real wages tends to increase them in the recipient country and correspondingly reduce them in the sending country.

If multinationals bring new ideas to their host country, foreign investors should put upward pressure on wages as the marginal productivity of workers in those plants rises. If this productivity advantage is significant, equilibrium wages should rise in response to increases in FDI. If, however, FDI affects labour demand in the same way as domestic investment, the role of foreign direct investors in transmitting

productive knowledge is limited. In this section, we first examine whether foreign firms pay higher wages than their UK counterparts, and then we test the hypothesis that foreign-owned firms have positive and significant effects on the average wages in domestic firms, i.e. wages spillover effects.

### **6.7.1 Do FOSs pay more?**

We start by estimating equation (i) in Table 6.6, where the average wage in firm  $i$  in year  $j$ ,  $W_{ij}$ , depends on whether the firm is of foreign nationality. Results in the equation (i) shows that foreign ownership is positively and significantly related to average wages. This may indicate that a significant share of the observed productivity differential identified in equation (6.4) takes the form of higher returns to domestic factors of production.

An interesting question is why FOSs should choose to pay “premium” average wages rather than competitive wages which would allow them to internalize productivity advantages in the form of higher profits. One hypothesis is provided by the efficiency wage literature, which argues that, over some range, productivity is an increasing function of the wage rate. When FOSs enjoy higher labour productivity, they must find it profitable to pay non-competitive wages. A second is that, it may be necessary for FOSs to pay supra-competitive wages to unionized workers, since countervailing bargaining power in these type of firms is deemed to be stronger, in order to avoid strikes.

Similar to the analysis of labour productivity differences above, results from equation (ii) indicate that, once we hold some conditioning factors constant, the

significance of foreign ownership as an explanatory variable falls and foreign firms do not seem to pay higher wages than their local counterparts. The  $CI_{ij}$ ,  $IA_{ij}$ ,  $HC_{ij}$  and  $SIZE_{ij}$  coefficients are positive and highly significant, consistent with implications drawn from the efficiency wage literature. As concluded by Lawrence and Schultze (1990), high capital intensity encourages firms to pay efficiency wages, since it is more costly for capital intensive firms to suffer employee shirking or absenteeism. High levels of intangible assets per capita are associated with high levels of human capital, and the skills of the labour force. Efficiency wages theory argues that human capital or labour quality, such as workers' level of knowledge, is positively linked with the level of their wages. The higher level of wages in FOSs may also be related to firm sizes, since large-sized firms tend to pay higher wages ( Brown and Medoff, 1985).

#### **6.7.2 Is there a wages spillover effects?**

The impact of MNEs' wages can be interpreted in a standard supply and demand framework for labour. If MNEs have a productive advantage over their domestically owned counterparts, an increase in foreign presence in the labour market will raise productivity, thereby raising labor demand for a given set of factors. Provided the labour supply curve in the local labour market is upward sloping, the result will be an increase in the equilibrium wage. In industries where there is a significant increase in foreign penetration, the increased employment in high-wage, high-productivity firms therefore, *ex ante*, increases wages in the domestic sector. Firms experience increased wage demand and are forced to pay more to keep their workers.

More explicitly, we change equation (6.6) into the following one:

$$W_{uk,ij} = \alpha + \beta_1 CI_{ij} + \beta_2 IA_{ij} + \beta_3 HC_{ij} + \beta_4 SIZE_{ij} + \beta_5 FP_{ij} + \varepsilon_i \quad (6.11)$$

Where:  $W_{uk,ij}$  is the average wages in UK locally-owned firms. If the coefficient on foreign presence  $FP$  is positive, then a greater foreign presence increases wages in the DOEs. If foreign investors bring with them knowledge that raises average productivity, then  $\beta_5$  will be greater than zero. This view is adopted by Driffield (1999), who found that 33 per cent of the total wage increases paid by UK manufacturing over the period was due to inward investors paying higher wages, thereby pushing up wages paid by domestic firms.

**Table 6.6**  
**Wages and Wages Spillovers**

Equations	Results
(i)	$W_{ij} = 0.17N_{ij}$ <span style="float: right;"><math>\bar{R}^2 = 0.76</math></span> (8.21***)
(ii)	$W_{ij} = 0.03CI_{ij} + 0.05IA_{ij} + 0.92HC_{ij} + 0.02SIZE_{ij} + 0.01N_{ij}$ <span style="float: right;"><math>\bar{R}^2 = 0.98</math></span> (1.74*) (14.39***) (32.18***) (5.53***) (0.91)
(iii)	$W_{uk,ij} = 0.13CI_{ij} + 0.04IA_{ij} + 0.95HC_{ij} - 0.03SIZE_{ij} + 0.09FP_{ij}$ <span style="float: right;"><math>\bar{R}^2 = 0.79</math></span> (3.34***) (5.41***) (9.79***) (-1.34) (4.25***)

Note: (1) Equation (i) and (ii) reports the results of substituting  $LP_{ij}$  with  $CP_{ij}$  and  $W_{ij}$  as dependent variables in equations (6.4) and (6.5); Equation (iii) reports the result for the equation (6.11); (2)\*, \*\*, and \*\*\* denote significance at 10%, 5% and 1% levels respectively; (3) Figures in the Parentheses are  $t$  statistic; (4) For convenience of expression, industry dummy variable coefficients are suppressed.

It should be noted that, if foreign firms “steal” the best domestic workers or only invest in the most productive or highest paying domestic firms, increases in FDI



should be uncorrelated with  $W_{uk,ij}$ , since the overall pool of labor has not changed, and the coefficient should be zero.

The result in equation (iii) shows that in UK manufacturing industry, higher or increasing foreign investment is associated with higher wages for workers in the DOEs. This appears to imply that higher wages in foreign firms spill over to domestic firms in UK manufacturing industry. These wage increases are consistent with studies showing that foreign firms have a productive advantage, suggesting that their presence shifts the labour demand curve.

### **6.7.3 Wages and the productivity gap**

While there is evidence of wage spillovers to domestically owned firms, whether these spillovers are the result of human capital accumulation or simply higher productivity in foreign-owned firms, as discussed in the efficiency wages literature is still unclear. Wage spillovers from MNEs to domestic UK workers could in principle occur even without any increase in the human capital of workers in domestically owned enterprises. These “pecuniary” spillovers are likely to be extremely difficult to disentangle from a spillover due to increases in human capital. However, one way to distinguish between the two types of spillovers would be to test whether higher wages in domestic firms are also accompanied by higher productivity-which would suggest a human capital spillover, not merely a wage effect due to upward pressure on wages exerted by foreign entrants. If the observed wage differentials between foreign and domestic enterprises can be explained by productivity differentials, the positive wage impact of foreign investment on remuneration in DOEs should translate into a productivity impact that is positive for DOEs.

As shown in table 6.2, a simple comparison of labor productivity shows a margin of roughly 28% in favour of FOSs. In contrast, the data indicates an average wages differential of 19%. The productivity differential is surprisingly similar to the wage differentials between foreign and domestic enterprises for the UK. In fact, the correlation coefficient between the two is 0.76. With high turnover or rapid rates of technological diffusion between foreign and domestic enterprises, wage differentials between foreign and domestic enterprises should become (over time) quite small. From this perspective, low wage differentials could reflect the existence of spillovers between foreign and domestic firms.

The evidence on productivity presented above, combined with the results in Table 6.6, suggests that foreign investment is associated with both productivity and wage increases. Increased foreign investment raises productivity, and the resulting benefits to the firm are shared with its employees in the form of higher wages.

## **6.8 Conclusions**

This chapter has investigated the differences between domestic and foreign firms in the UK manufacturing industry. Foreign-owned firms are shown to have significantly higher levels of output and value-added per worker and correspondingly higher levels of factor usage, with higher levels of physical capital, intangible assets and human capital in particular. When controlling for input factors, foreign subsidiaries are still significantly but to a lesser degree more productive than UK-owned firms. Foreign subsidiaries are less efficient than UK indigenous firms in terms of total factor productivity. This is largely due to the UK-owned firms having

advantage over their foreign counterparts in capital productivity, and cannot be explained by those factors identified in explaining the labour productivity gap.

The relatively small magnitude of the productivity gap in some industries can partly be attributed to the spillover benefits accrued to the existence of foreign firms and the use of more intangible assets in these firms. However, the results demonstrate the exact same conclusion as that of Chapter 4, i.e. the extent to which the indigenous firms benefit from these spillovers is negatively related to technology gap proxied by intangible assets per capita between the foreign and locally-owned firms. It also should be noted that the coincidence of the productivity gap and spillover effects indicates that any “spillover” gains in productivity resulting from an increase in foreign employment, made by the domestic producers, are not enough to alleviate their competitive disadvantages compared with the inward investors.

Foreign-owned firms also pay their workers higher wages, which may reflect an efficiency wage effect, or differences in skill levels. The results also point to a wage spillover effect, which means that a greater foreign presence increases wages in the UK-owned firms. In addition, we have found that productivity differentials are quite similar to the wage differentials between foreign and domestically-owned enterprises.

Objections can be raised against the above various explanations for the performance differential too. One of them is by Doms and Jensen (1998) in their study of US manufacturing . They were able to break down US domestically-owned firms into those that are multinationals and those that operate only in the home

market. They find that the real difference is between multinationals and non-multinationals, not foreign and domestically owned firms. At any moment there is a range of capabilities amongst a country's firms. The better companies develop specific advantages. These allow them to compete successfully in foreign markets and consequently to go multinational (Dunning, 1981). The foreign-domestic productivity gap that they observed simply reflects this process. Indeed, the observed gap might be on this view rather misleading since the performance of the more successful domestically-owned multinationals is being obscured by their less successful colleagues who operate only in the home market. It would require much more work beyond the scope of this study to identify the UK multinationals in our database. But even if some British multinationals have high productivity, they represent a comparatively small proportion of UK employment, and they do not dominate the average level of UK domestic productivity.

Nevertheless, the empirical results have important policy implications for UK indigenous firms. The evidence is quite clear and consistent that any policies encouraging technology transfer and spillovers proposed in the previous chapters apply here. Spillovers have positive impacts on the convergence in productivity levels over time via improving the performance of UK locally owned firms. Given that ownership advantages may vary among subsidiaries of different nationalities, Should the policies be set to target foreign firms of a particular nationality? The next chapter examines the relationship between the relative economic performance of foreign subsidiaries and their national origins.

# **CHAPTER 7**

## **FACTOR DIFFERENCES, COUNTRY-OF-ORIGIN EFFECTS AND RELATIVE LEVELS OF PRODUCTIVITY OF FOREIGN SUBSIDIARIES**

### **7.1 Introduction**

Chapter 6 shows that foreign subsidiaries outperform UK locally-owned firms. This chapter investigates whether there are performance differences among foreign subsidiaries themselves since these subsidiaries are from different national origins. Dunning (1988b) argues that the pattern of foreign investment should vary by its country of origin. More precisely, firms actively involved in specific foreign direct investment will raise their involvement to a higher level than firms from other countries because the nature of their domestic market has produced firm-specific advantages. Firms will exploit specific markets actively using these ownership advantages.

There is a limited empirical literature on the economic performance of foreign subsidiaries in connection with their home origins. In a comparison of inward investment by US companies in the 1950s and Japanese companies in the 1980s, Dunning (1988c) argues that the former largely sought to transfer product and marketing innovations to the UK, whereas the latter were more concerned to transfer the managerial practices and quality standards used by the parent companies. Kim and Lyn (1989) compared the relative performance of U.S. indigenous firms with those from Canada, Japan, Western Europe and other countries. Globerman, et al (1994) use factor proportion differences to explain the relatively superior performance

of FOSs from the U.S, EU and Japan in comparison to those of Canadian locally-owned firms. These studies have revealed a variety of important links between foreign subsidiaries' economic performance and their nationalities.

The issue of foreign subsidiary's nationality is particularly relevant in the light of policy implication for attracting foreign direct investment (FDI). Knowledge of whether and how the home country of a FOS affects the benefits of FDI to the host country may help UK's promotion efforts to target more effectively subsidiaries of certain home countries and maximize the benefits from such FDI.

One feature of this study is that we control the influences of the source of ownership by identifying foreign-owned firms by home country of the owner. The subsidiaries of EU, U.S., and Japan are compared with UK indigenous firms. We treat Europe as a single country in this study, because the vast majority of investment of European origin comes from the 15 European Union countries. It is recognized that there are clearly cultural distinctions among EU countries. These distinctions begin to blur when one examines the business culture. However, the level of economic development among the major European investors is also quite similar. Another feature is that we control for the influences of industry distribution by using firm-level data which allow the industry's influence to be constant through the use of dummy variables corresponding to SIC sub-industries classification (14 industries, see Table 7.1).

Our work improves upon the above studies in three aspects. First, we use panel data and a large set of countries. Second, we control for the impact of industry

distribution of firms of different home origins. Thirdly, it is grounded in the theory of multinationals and other recent theoretical developments.

Section 7.2 discusses the theoretical framework. The third section describes the sample and the fourth section presents the empirical models employed. The empirical results are given in the section 7.5 and the last section concludes the chapter.

## **7.2 Theoretical development**

The aim of the present chapter is to investigate whether there are differences between firms located within the same country with corporate parents of different national origins. This situation occurs when a multinational firm establishes or acquires subsidiaries beyond its domestic boundaries.

As is well known, the interaction between country specific factors and firm specific factors as sources of global competitive advantage has been the subject of an extensive literature. Theories of FDI have emphasized the existence of intangible assets and competitive advantages of the investing firm (Caves, 1971; Hymer, 1976; Dunning, 1977), which can offset the disadvantages of operating in a foreign country. A persistent finding has been the importance of “intangible assets” or technological capabilities that embody the firm’s competitive advantage over rivals in foreign markets. This advantage permits a firm to engage in direct investment overseas by transferring these intangible and technological assets to a new market. These assets reflect the “ownership advantage” of a firm (Dunning, 1977). Their location is

influenced by the size of the market, as well as the importance of scale effects (Helpman and Krugman, 1985; Brainard, 1993).

Caves (1996) has noted the similarity of this approach to the resource-based view of the firm. He argues that the role of proprietary assets might rest on know-how shared among employees of the firm and specifically the creation of value by the proprietary asset might rest on a set of skills or repertory of routines by the firm's team of human (and other) inputs (Nelson and Winter, 1982). Thus the concept of "intangible assets" is closely related to the concept of "core competencies" discussed in business administration, and to that field's debate over the "resource-based view of the firm". Therefore two related home country factors can be identified here: home based technological advantages and domestic inter-firm rivalry. It can be assumed that the greater the technological advantages and more intense the rivalry, the better the MNEs will perform in the overseas markets.

The eclectic theory of Dunning (1977) also suggests that the ownership-specific advantage may be unevenly distributed according to the countries of origin and destination. According to Dunning (1980), factor inputs to the production process consist of two types: location-specific inputs (natural resources, etc) available to all firms and firm-specific inputs such as technology and management skills, which the firm itself may create. A key characteristic of these firm-specific inputs is that:

*Although their origin may be linked to location-specific endowments, their use is not so confined. The ability of enterprises to acquire ownership endowments is clearly not unrelated to the endowments specific to the countries in which they operate and particularly their*



*country of origin. Otherwise, there would be no reason why the structure of foreign production of firms of different nationalities should be different. But, in fact, it is so - and substantially so* (Dunning, 1980, p. 10).

That is, firms in certain industries of a particular country possess specific advantages that accrued to them because of the way their industries developed in their home country. These firms may then utilize these advantages by exploiting foreign markets. Necessarily, the firm can only exploit these endowments in conjunction with location-specific endowments present in the host country.

One polar version of this view is the “random advantage” model from Davies and Lyons (1991). This model assumes that specific assets are developed by firms in a way that is not systematically related to industry factors. Multinational firms, whatever their country or industry of origin, would all be more productive than indigenous non-multinationals in their host countries, and exercises such as the present one would be fairly pointless.

However, in the literature of the competitive advantage of nations, the impact of the home country environment on a firm’s competitive advantages (core competencies in some management literature) has been attributed to the so-called “Porter diamond” (Porter, 1990) via, access to resources and assets; consumer demand; inter-firm competition; linkages with foreign or domestic firms and institutions. In Porter, strong global competitive ability generated by the core competencies of MNEs is the result of the characteristics of the MNE's home base.

According to Porter, multinational status is a reflection of a company's ability to exploit strengths gained in one nation in order to establish a position in other nations. The technological profile of a creative subsidiary will reflect the distinctive specialised technological capacities of the country in which it is located.

In Porter, successful global competition is seen as a result of the characteristics of the MNE's home base. A firm's home base is considered to be the nation where it retains effective strategic, creative and technical control, i.e. it is the source of the MNE's core competencies. In addition, it is considered as central "to choosing the industries to compete in as well as appropriate strategy" (Porter, 1990). The implication of Porter's view is that operations of an MNE with different home bases must be largely autonomous from the other operations in the MNE.

The Porter approach ignores the impact on the capabilities of the MNE derived from global scope and has been augmented by a "double-diamond" concept (Rugman and Verbeke, 1993 and Rugman, et al, 1995) that embraces the host country environment as well. They argue that Porter's treatment of foreign-owned subsidiaries in smaller countries is incomplete and misleading. These need access to a triad market and their activities are better explained by a "double diamond". They point out that, while multinational subsidiaries benefit from worldwide learning and global scope economies, they are becoming increasingly independent from individual countries. Multinational firms engaged in international competition need to take account of demand conditions, production factors and the forces driving industry competition in both home and host country. The advantage of the "double diamond" approach for the analysis of MNEs and innovation is that it combines the impact of both the home and

host countries. The disadvantage, inevitable and not surprising, is that it requires rigor and parsimony to pare down each component of the model to synthesize the firm's experience.

In a recent survey of MNE executives, Dunning (1996) provides new empirical information on the home/host country links. An important finding of the survey is that foreign-based activities are seen as a source of competitive advantage of the leading MNEs, and likely to increase in significance in this regard. Since most studies of MNEs have concentrated on technology diffusion, this study is important in underlining that, with the ongoing spread of knowledge or "techno-globalism", the MNE is a two-way funnel for technology. Global strategies will increasingly reflect this linkage between location and capabilities.

While transnationality by FDI was significant, the survey results supported the "home link" view that the primary source of innovation capabilities stemmed from home country features, such as high quality human capital and innovation-related infrastructure. When the data were disaggregated by country of origin, a number of home country differences are revealed, especially between Japan and the United States.

A radically different approach to the home country impact is the concept of a national innovation system (NIS) (Freeman, 1987; Nelson, 1993; Ostry and Nelson, 1995). This vastly extends the institutional approach by embedding the firm in a "system" (no precise boundaries are defined), or set of institutions which interact in the production, diffusion and use of new technologies, and thus determine the firm's

innovative capability and performance. This approach stems from a range of different sources, but it is essentially evolutionary (unplanned, uncertain) and interactive (as firms, people, organizations and institutions interact, the NIS evolves).

An alternative model for the above approaches is the “world best practice” or “world-class practice” view in which MNEs are representative of the best practice technology that is available in their country of origin. Within the manufacturing area, the ability of manufacturing to perform at world-class levels in an increasing global competitive environment is becoming more important. Hodgetts et al (1994) defined “world-class organisations” as those that have mastered total quality and learning, and are recognized as the best overall (not just in their fields) in at least several strategically important areas.

In such a model, FOSs need not necessarily be much more efficient than their home country counterparts who do not operate overseas. An implication of this model is that MNE's advantage when producing in a host country would be positively correlated with the international productivity differential between its parent country and the host country.

The USA and Japan are commonly cited as leading the rest of the world in manufacturing practices and performance, and many business practices associated with world-class manufacturing were initiated in either Japan or the USA. Foreign ownership may provide a “platform” for the diffusion of “best practices” in manufacturing to sites in other countries. In particular, much interest has been paid recently to the role of Japanese plants operating overseas in diffusing manufacturing

practices associated with world-class performance. For example, Japanese companies which have located motor vehicle and electronics production in the UK have been successful in their endeavours.

All the above models recognize implicitly, to a varying degree, the influences of the origin of a subsidiary on its performance in the host country. Assuming other factors such as market conditions constant, another task of the current study is therefore to test the hypotheses that the relative performance of FOSs depends on their countries of origin. In fact, it has been suggested that the consequences of the operations of foreign firms for the host country are strongly conditioned by the location of the foreign affiliates' home base (Monitor Company, 1991).

### **7.3 The sample**

The empirical data used in the present study are mainly taken from FAME database. The whole sample is exactly the same as the one used in Chapter 6. Here we group the firms into four groups according to nationalities: UK-owned, EU-owned, US-owned and Japanese-owned. Industry effects are captured by classifying firms to 14 sub-manufacturing industries-the broadest classification of the SIC. A description of the data can be found in Chapter 6. An overview of the sample is provided in the Table 7.1.

As noted earlier, differences in relative productivity performance across firms can arise in a number of ways with which resources are used. It is supposed that any

Table7.1

## An Overview of the Sample

Industry		Number of firms					
SIC	Name	UK	EU	US	Japan	Foreign*	Total**
DA	Food , beverage, and tobacco	805	206	66	8	280	1085
DB	Textile products	610	50	48	12	110	720
DC	Leather products	93	8	7	0	15	108
DD	Wood products	206	33	4	0	37	243
DE	Pulp, paper, publishing	1605	344	130	8	482	2087
DF	Coke, petroleum, and nuclear	41	26	20	0	46	87
DG	Chemical products	736	297	216	29	542	1287
DH	Rubber and plastic products	503	121	54	6	181	684
DI	Other non-metallic mineral products	293	72	34	2	108	401
DJ	Basic metals	1821	378	265	17	660	2481
DK	Machinery and equipment	710	252	179	22	453	1163
DL	Electrical and optical products	1292	325	390	93	808	2100
DM	Transport equipment	343	92	51	5	148	491
DN	Other	908	220	151	26	397	1305
Total		9966	2424	1615	228	4267	14233

Notes: (1) Source: the author's own calculation from the FAME database; (2) Foreign=EU+US+Japan; Total=UK+Foreign

Table 7.2

## Comparative Levels of Productivity (Foreign/UK)

Industry	LP			TFP			CP		
	EU	US	Japan	EU	US	Japan	EU	US	Japan
Food, beverage	0.93	1.74	1.49	0.73	1.07	0.91	0.75	1.07	0.65
Textile products	1.26	1.27	1.15	0.74	1.07	0.78	0.56	0.95	0.61
Leather products	2.58	1.11		1.23	0.61		0.96	0.46	
Wood products	1.21	1.06		0.78	1.43		0.66	1.80	
Pulp, paper, publishing	1.28	1.05	0.92	1.27	0.98	1.34	1.30	0.96	1.87
Coke, petroleum, nuclear	1.75	2.16		1.44	1.04		1.61	0.84	
Chemical	1.02	1.09	1.04	1.04	1.13	1.90	1.07	1.22	3.36
Rubber, plastic	1.17	1.12	2.91	0.98	0.95	0.79	0.96	0.94	0.74
Other non-metallic Mineral	1.03	1.15	1.89	0.82	1.30	4.78	0.77	1.49	13.69
Basic metals	1.01	1.08	0.82	0.80	1.05	0.65	0.70	1.08	0.55
Machinery, equipment	1.16	1.15	1.46	1.17	1.17	1.37	1.39	1.25	1.23
Electrical	1.13	1.32	1.38	1.00	1.19	1.22	0.89	1.20	1.33
Transport equipment	0.92	0.88	1.33	0.81	3.33	0.45	0.75	1.43	0.21
Other	1.20	1.27	1.08	1.06	1.09	1.06	0.43	1.06	0.63
Total manufacturing	1.25	1.25	1.11	0.92	1.17	1.29	0.91	1.13	1.78
Standard error	0.33	0.33	0.12	0.33	0.70	1.26	0.33	0.32	3.55

Notes: (1) Source: the author's own calculations from the FAME database; (2) Figures for 'total manufacturing' include 14 industries for the EU and the US and 11 industries for Japan. The EU and US figures are almost unchanged if leather, wood products and coke, petroleum and nuclear industries are excluded.

differences in labour productivity levels between DOEs and FOSs in a given industry arise, among other things, from differences in factor inputs. A sophisticated version of the production function would not only include traditional factor inputs such as capital labour and materials, but also allow for variations in the use of technology and human capital and the exploitation of economies of scale.

Table 7.2 shows the average labour (*LP*), capital (*CP*) and total factor (*TFP*) productivity advantages that FOSs have over UK indigenous firms by industry and nationality of the subsidiary. Clearly there is a great deal of diversity, but nevertheless a number of patterns emerge. First, the foreign subsidiaries, whatever their nationalities, enjoy higher average labour productivity (*LP*) in almost every industry. Both US and EU owned firms are more efficient than UK owned firms, but there is no obvious difference between the two groups of firms. Japanese owned firms outperform UK-owned firms, but they enjoy lower labour productivity than their EU and U.S counterparts. The average gap between FOSs and DOEs then is 1.20. Second, with respect to total factor productivity (*TFP*) the average gap was generally smaller except in the case of Japanese owned firms. In fact, the EU-owned firms even enjoy a lower level of *TFP* than UK owned firms. This is partly because capital productivity (*CP*) is higher in UK owned firms in nine industries of our sample. The average capital productivity of EU owned firms is 91 percent of that of UK owned firms. The average *TFP* gap between FOSs and DOEs on the whole is 1.13, which is smaller than the *LP* gap (1.20).

Since most previous studies in this area use labour productivity, for reasons of comparability this study also focuses on labour productivity. First we establish some relationships.

## 7.4 Empirical models

As hypothesized above, the labour productivity of a firm depends to some extent on its industry and its nationality. Following Globerman *et al* (1994) we thus propose a model based on a panel data set. In this model, a set of industry dummy variables is used taking “food products, beverages, and tobacco” as the base industry. Ownership dummy variables represent UK-owned, EU-owned, US-owned and Japanese-owned firms, with UK ownership used as the constant. Thus we have:

$$LP_{ij} = \alpha + \sum_{k=1}^{13} \gamma_{kij} I_{kij} + \sum_{h=1}^3 \delta_{hij} N_{hij} + \varepsilon_{ij} \quad (7.1)$$

where:  $LP_{ij}$  is labour productivity of firm  $i$  in the time  $j$ . It is measured by value added per worker,  $\alpha$  is the intercept that includes the average effect of a UK firm in the food product, beverages and tobacco industry,  $I_{kij}$  is a dummy variable equal to one if firm  $i$  is in the industry  $k$  and zero otherwise, and  $N_{hij}$  is a dummy variable equal to one if firm  $i$  is of nationality  $h$  and zero otherwise. In our sample,  $i = 14,233$  firms covering 14 industries,  $k=1 \dots 14$  and  $j = 1,2,\dots,J(=5)$  covering the years 1992-1996.

Assuming that some of the home country differences in productivity can be attributed to differences in factor intensities, one may propose that the level of labour productivity is influenced by the following variables: physical capital intensity ( $CI$ ); intangible assets per worker ( $IA$ ); human capital ( $HC$ ); and the size of firms ( $SIZE$ ).



The influence of these factors are separated from other "nationality" and industry specific characteristics:

$$LP_{ij} = \alpha + \beta_1 CI_{ij} + \beta_2 IA_{ij} + \beta_3 HC_{ij} + \beta_4 SIZE_{ij} + \sum_{k=1}^{13} \gamma_{kij} I_{kij} + \sum_{h=1}^3 \delta_{kij} N_{hij} + \varepsilon_{ij} \quad (7.2)$$

Positive relationships are expected between the dependent variable and all explanatory variables except the two dummy variables.

As noted earlier, home-country effects on the performance of foreign subsidiaries may reflect the influence of a wide variety of factors, especially those conferring ownership-specific advantages reflected in higher levels of productivity. We then establish link between these individual determinants of labour productivity and industry and nationality by the following equations:

$$CI_{ij} = \alpha + \sum_{k=1}^{14} \gamma_{kij} I_{kij} + \sum_{h=1}^3 \delta_{kij} N_{hij} + \varepsilon_{ij} \quad (7.3)$$

$$IA_{ij} = \alpha + \sum_{k=1}^{14} \gamma_{kij} I_{kij} + \sum_{h=1}^3 \delta_{kij} N_{hij} + \varepsilon_{ij} \quad (7.4)$$

$$HC_{ij} = \alpha + \sum_{k=1}^{14} \gamma_{kij} I_{kij} + \sum_{h=1}^3 \delta_{kij} N_{hij} + \varepsilon_{ij} \quad (7.5)$$

$$SIZE_{ij} = \alpha + \sum_{k=1}^{14} \gamma_{kij} I_{kij} + \sum_{h=1}^3 \delta_{kij} N_{hij} + \varepsilon_{ij} \quad (7.6)$$

In all the equations, variables are in logarithmic form except for the industry and ownership dummies. Equations are estimated through pooled ordinary least squares (POLS).

## 7.5 Empirical results

Equation (7.1) in Table 7.3 shows that labour productivity in foreign subsidiaries whatever their nationalities, is higher than in UK-owned firms, holding industry influences constant. This finding is consistent with most other studies in the area and it also mirrors results in international productivity differences. For example, it is reported that the US has an approximate 86 percent productivity advantage over the UK in 1987 (Ark, 1992). In comparison, Germany's productivity advantage over the UK was 22 percent in 1987 (O'Mahony, 1992), the Netherlands' was 52% in 1984 (Ark, 1990a), and France's was 37 percent in 1984<sup>15</sup>(Ark, 1990b).

**Table 7.3**  
**Regression Results**

Equations	Results
(7.1)	$LP_{ij} = 0.21EC_{ij} + 0.22US_{ij} + 0.27JAPAN$ (4.51***) (4.67***) (5.25***) $\bar{R}^2 = 0.47$
(7.1a)	$LP_{ij} = -0.01EC + 0.08Japan$ (-0.20) (1.54) $\bar{R}^2 = 0.47$
(7.2)	$LP_{ij} = 0.10CI_{ij} + 0.03IA_{ij} + 0.52HC_{ij} + 0.04SIZE_{ij} + 0.10EC + 0.13US + 0.21JAPAN$ (4.78***) (4.35***) (8.32***) (1.53) (2.49***) (3.13***) (4.48***) $\bar{R}^2 = 0.66$
(7.3)	$CI_{ij} = 0.45EC + 0.08US + 0.50JAPAN$ (3.42***) (0.64) (3.48***) $\bar{R}^2 = 0.30$
(7.4)	$IA_{ij} = 0.01EC + 0.02US - 0.01JAPAN$ (1.29) (2.15)** (-0.91) $\bar{R}^2 = 0.44$
(7.5)	$HC_{ij} = 0.12EC + 0.17US + 0.20JAPAN$ (2.51***) (3.64***) (3.98***) $\bar{R}^2 = 0.26$
(7.6)	$SIZE_{ij} = 0.19EC + 0.40US + 0.45JAPAN$ (1.84**) (3.77***) (3.87***) $\bar{R}^2 = 0.49$

Note: (1) equation (1)† reports the results of comparison among FOSs of different nationalities by substituting US for UK as the base country. (2) \*, \*\*, and \*\*\* denote significance at 10%, 5% and 1% levels respectively. (3) Figures in the parentheses are *t* statistic. (3) For convenience of expression, industry dummy variable coefficients are suppressed.

<sup>15</sup> Many studies found that the UK's productivity gap with its major international competitors has been reduced in recent years.

As table 7.3 shows, by comparison the productivity gap between FOSs and DOEs seems modest and is not directly proportional to the gap between the UK and the corresponding home countries. This may indicate that the foreign firms' original productivity advantage is negatively affected by the UK market conditions. Foreign affiliates seem to be a hybrid of both home and host country manufacturing processes, and consequently fall between the two in terms of performance. In fact, the observed UK-owned firms' productivity gaps with FOSs in the EU and in the US are of similar magnitude (see Table 7.2), although it is usually claimed that US companies enjoy higher productivity than those of European origin. An explanation could be that with European integration, geographical adjacency when producing in the UK might partly offset some of its disadvantages over those firms from the US. It might also be argued that the MNEs from EU are not really as multinational as the U.S. ones, since a large proportion of their foreign operations may simply occur in their backyard, that is, in neighbouring nations. All this suggests that the relative performance of foreign subsidiaries is jointly determined and is likely to be influenced by both home country base and host country market conditions. These conclusions appear to coincide with the spirit of the "double diamond" framework (Rugman and Verbeke, 1993).

In a broader context, given the importance of technology, the smaller productivity gaps between US and EU subsidiaries also reflects changes in knowledge production strategies, one facet of what is now called techno-globalism. The dynamics of international transfer of technology are widened from a predictable one-way flow from home to host countries to a global and interactive process of technology generation and application. An increase in technology alliances in the

fields of information, biotechnology and new materials reduces the role of the simple two-way technology link between the home and host country. In addition, the firm not only achieves advantages from its parent at home, but also benefits from a "system" in which it nests, or set of institutions by exchanging ideas and technology flow.

Equation (7.1a) highlights the productivity differences among FOSs of different home countries controlling for industry effects. Taking the US as a constant, FOSs from EU and Japan are compared. It shows that the US owned firms outperformed the EU owned firms and under-performed Japan owned firms, although the coefficients are not statistically significant<sup>16</sup>.

As expected, equation (7.2) of Table 7.3 shows that capital intensity, intangible assets per worker, human capital, and larger firm size contribute positively to value-added per employee in all firms. All variables except size, are significant at the 0.01 level. The nationality variables are still statistically significant when these explanatory variables are added to equation (7.1). This indicates that, when one holds constant some obvious conditioning factors, UK-owned firms are still less efficient than subsidiaries of other national origins.

Despite the finding noted directly above, we follow the same approach differences in factor intensities across nationality groups. Equation (7.3) shows that

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<sup>16</sup> Further factor analysis shows that, while the EU and Japan owned firms are more capital intensive than those of the US -owned, the latter use more intangible assets than those especially from Japan. In addition, the US owned firms are significant larger and more human capital intensive than the EU owned firms. The Japan owned firms are using more skilled employees and larger than the US owned, although not significant.

there is no significant difference in capital intensity between the UK and U.S. owned firms. This is a bit surprising given that relatively more U.S firms are located in the capital-intensive industries in our sample, though it seems consistent with Kim and Lyn (1989) who find that foreign subsidiaries in the US are more capital intensive than their indigenous fellows. In contrast, European and Japanese owned firms are significantly more capital intensive than the UK indigenous firms.

Equation (7.4) shows first, that US subsidiaries enjoy a higher level of intangible assets per employee, while no significant differences are found between the UK and the EU owned firms in using intangible assets. Together with the evidence in equation (7.3), it appears that US firms use more advanced technologies that may render physical capital less important. This finding is also consistent with many previous studies (see, e.g. Broadberry and Craft, 1990; Ark, 1990a; and Carr, 1992), which claim that British firms have been less committed to R&D than their major international competitors. It is interesting to note that, contrary to popular belief, the UK owned firms are using significantly more intangible assets than their Japanese counterparts. A possible explanation for this is that while the UK has clearly been able to attract relatively labour intensive investments, it has fared relatively poorly in attracting more R&D intensive investments. This result may however be due to the data quality of intangible assets associated with accounting practice<sup>17</sup>. We are not led to conclude that the Japanese direct investment in the United Kingdom is motivated by the seeking of new technologies resident in the UK. We would rather believe that they are motivated by the exploitation of an initial technological advantage, or, they are attracted by what the UK economy provides, since the majority of Japanese

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<sup>17</sup> The research intensity of affiliates in the UK is below the European average, with most research intensive affiliates being located in Germany, France, Belgium and Ireland (Barrell and Pain, 1997).

subsidiaries are clustered in the electronics industry<sup>18</sup>. This conclusion offers some support to the "best practice model", although we find that foreign-owned firms of different nationalities may have different reasons for investing in the UK.

Turning to human capital in equation (7.5), the result shows that the lower level of human capital in the DOEs is a possible explanation for underperformance. This is consistent with other research (Prais, 1981, Barnett, 1986, and Sanderson, 1988) which shows that in recent years deficient education and training of workers on the shopfloor, from foremen downwards, has had a major impact in holding back British productivity levels relative to those of foreign countries. In fact, there is also a widespread tendency to be critical of the quality of British management across the economy as a whole. This pattern of results is consistent with other studies which highlights both the higher level of technical and scientific skills in the workforce of FOSs (Mason and Wagner, 1994 and Carr, 1992).

As indicated in equation (7.6), the relatively smaller scale of operation of DOEs also contributes to the observed productivity gaps. Table 6.2 shows foreign subsidiaries in the sample to be generally larger than those of locally owned firms, which account for 70 percent of the total firms in our sample<sup>19</sup>. The industry statistics in the sample shows that UK does have many larger plants, but many of them are located in light industries with generally limited economies of scale. In addition large plants in the UK have been more hampered by unfavourable labour relations. Thus

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<sup>18</sup> Papanastassiou and Pearce (1994/95) find that the use of local scientific institutions (e.g. universities, independent or industry-founded labs) to carry out R&D takes a relatively limited position in foreign subsidiaries' technology supply.

<sup>19</sup> In contrast, international productivity comparison literature shows that, British firms are smaller than those of the US, but they at least match those in the EC (Davies and Caves, 1987).

these larger firms do not seem to have yielded much benefit in terms of productivity performance, and have not served to narrow the productivity gap.

## **7.6 Conclusions**

This chapter has established a modified version of Globerman model (1994) continuing to study the comparative performance between foreign and UK owned firms in manufacturing industry. The results show that, holding industry influences constant, foreign-owned companies fared considerably better than those of domestically-owned firms, suggesting a “home team disadvantage”. This is consistent with the conventional ownership advantage assumption in FDI theory. Given that larger magnitude of international productivity gaps between the UK and the corresponding countries, the results imply that the initial advantage of foreign firms may be negatively affected by the UK market conditions. Therefore the study indicates that the relative superior performance of foreign subsidiaries is jointly determined by the host and home country conditions. This is consistent with the “double diamond model”.

This chapter again finds empirical evidence supporting the importance of factor proportion differences in the relative performance of FOSs in the UK. We find that, while the greater usage of skilled labour and the larger size of operations in FOSs significantly contribute to the observed productivity gaps, the impact of capital intensity and intangible assets depends on the nationality of these firms. Even though our focus is only on a narrow set of factors, the performance of a subsidiary is found to depend also on the levels of the host country variables associated with the

subsidiary's productive activities. These include the availability of quality labour force, and investment in plants, equipment and intangible knowledge assets.

This study also finds that the observed labour productivity gap between FOSs and DOEs is not significantly sensitive to the foreign subsidiary's home country. However, the reasons for foreign superiority do vary across nationalities. We argue that the ownership advantage of FOSs may take different forms, depending on the origin of home country, the relative characteristics of both host and home country and heterogeneous motivations underlying FDI in the UK. Our results show that not all FOSs of different home countries enjoy technical advantages over DOEs, which is assumed to be one of the most important reasons for their superior performance. While the higher level performance of US subsidiaries is associated with the superiority of technology and other firm level competence variables, EU and Japan affiliates do not demonstrate significant technical advantages over UK owned firms in terms of intangible assets. The labour productivity advantages of EU and Japanese owned firms are due to higher capital intensity, a more skilled staff and the larger size of operations. Hopefully this study has contributed to the understanding of what drives the superior performance of FOSs in the UK.

The ownership advantage analysis of FOSs by country of origin raises important policy implications. Given the spillover effects associated with intangible knowledge assets, it might be wise for the UK government to target technologically advanced US firms, if more R&D is expected to be carried out in the UK instead of their home countries. Similarly, FOSs from the EU and Japan need to be encouraged if technologies represented by high capital intensity are sought after. At the same



time, domestic investment in machinery, equipment, human capital and R&D needs to be strengthened. This will not only enhance labour productivity in DOEs but also provide favourable conditions for FOSs to operate in the UK. By doing so, overall productivity in UK manufacturing will be improved.

## **CHAPTER 8**

### **CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH**

This chapter aims to conclude the study. Section 8.1 highlights the empirical findings and section 8.2 points out the policy implications of the study. The limitations of the research are examined in section 8.3 and the directions for further research are outlined in section 8.4.

#### **8.1 Main conclusions**

New growth theories stress that international linkages via trade and FDI may affect the productivity performance and economic growth of national economies (Grossman and Helpman, 1991). At present more is known about the impact of trade than FDI, particularly in developed economies. The majority of empirical studies follow Coe and Helpman (1995) in analysing the diffusion of technological activities between industrialized countries via technologies embodied in trade. On the other hand, in the literature on FDI, while the emphasis in the past was mainly directed to the immediate effect of FDI on employment, much of the interest is now on the technological implications of FDI, therefore on its longer term impact (Barrel and Pain, 1997). Inward investment is now widely regarded as an additional channel through which new ideas, working practices and technologies can arrive in host economies. The current study represents an attempt to analyse the technologically related indirect impacts of investment by technological advanced foreign MNEs in a developed country - the United Kingdom. Using firm and industry level panel data for UK manufacturing industry, this study has examined the intra-firm technology

transfer and the spillover effects from operations of foreign MNEs' subsidiaries. It has also compared the economic performance between foreign and UK locally owned firms.

The empirical part of this study begins with an investigation into the so-called first-round technology transfer (Lan and Young, 1996), i.e. from parent firm to overseas affiliates in chapter 3. The results show that the growth of labour productivity in US-owned affiliates in Scotland is positively linked to the R&D activity of their parents in the USA. It appears that, by our definition, US parents transfer technologies significantly to their operations in Scotland. It also shows that the extent to which the transfer of technology occurs is inversely linked to the transfer costs involved. The transfer costs are assumed to be associated with the technology being transferred itself, the characteristics of both the transferee and the transferor. Technology transfer is more likely to take place from those large and R&D intensive parents to those subsidiaries that are large and possess substantial absorptive capabilities in the product industries. The findings in this chapter supports the hypothesis 1 that MNEs transfer technology internally and the extent of the transfer has strong association with transfer cost, which relates to the characteristics of both subsidiaries and parent firms

One important finding is that the extent to which the subsidiary accepts technologies from its parent is positively associated with the technological capabilities of the subsidiary itself. This is consistent with the new technology transfer regime concerning its emphasis on the importance of transferees' technological capabilities (see for example, Ostry and Gestrin 1993 and Lan and Young 1996). While the

technological competence of the subsidiary is mainly represented by the level of human capital in our case, a unique finding from this study is that human capital in the subsidiaries appears to be more important in contributing to the growth of productivity than the parent's R&D. The impact of human capital is particularly important in smaller firms competing in the process industries.

Spillovers are the main channel through which foreign subsidiaries transfer technologies to host country locally-owned firms. The main benefit that the host country industries gain from operations of foreign owned firms is spillovers. Initially in chapter 4 a Caves-type single equation model is used on a full sample of 48 industries to test for the impact of technology spillovers resulting from the presence of foreign-owned firms. The results indicate that productivity in UK-owed firms is determined by their capital intensity, learning efforts, technological capabilities, the very presence of FDI and the existing level of technological competence (or technology gap) relative to that in foreign firms. The results show that the foreign presence of foreign subsidiaries has a positive significant impact on the labour productivity of UK locally owned firms.

Spillovers may be two-way in situations where the host is a developed country. The results in chapter 5 show that the productivity of foreign and UK-owned firms is jointly determined in a continuing interaction between foreign and local firms. This finding supports our hypothesis that spillovers from locally owned firms to foreign subsidiaries are important in situations where the host is a developed country. Incorporating the fact that the coefficient for foreign presence is again significant even in a simultaneous system, this represents a development of the results

in chapter 4. It suggests that technology spillovers to UK-owned firms be attributed not only to foreign presence but also to the interactions with and competition from multinational corporations operating in the UK industries.

The main finding from both chapters is that the spillover effects are positively related to the technological capabilities of local firms and the degree of competition between foreign and locally owned firms, and are negatively related to the technology gap between the two types of firms. These findings appear to be consistent with some recent studies (see for example, Ostry and Gestrin, 1993 and Wang and Blomstrom, 1992), which address the absorptive capacities of the receiving firms. Most spillovers are of a general nature, and therefore still require considerable innovative and design effort before they translate into viable commercial products. Spillovers represent only that portion of the innovation developed by a given firm or group of firms which was not excludable. In other words, “certain attributes of innovation dilute its public good nature to some degree and make substantive absorption investments a prerequisite for diffusion” (OECD, 1992, p.53). To take advantage of spillovers, therefore, firms must have some R&D capacity to make the partial information they acquire from the public pool of knowledge commercially significant. The findings from the two chapters are also in line with recent studies (Wang and Blomstrom, 1992; Kokko, 1994; and Aitken and Harrison, 1999), which emphasises the role of competition in generating spillovers associated with FDI. It should be noted, however, the effects of competition on spillovers are not always positive and they depend upon the technology gap. When the technology gap is not large, in such situations as where the host is a developed country, the competitive effects could be positive. By contrast, in other situations where, for example, the host is a developing country and the

technology gap is large, the competitive effects could sometimes be negative (Aitken and Harrison, 1999). These findings on spillovers do lend support for the hypothesis 2 and 3.

While locally owned firms may benefit from the presence of technologically advanced foreign subsidiaries, it is interesting to examine whether such benefits can lead to productivity convergence between the two types of firms. Chapters 6 and 7 have examined the performance differences between domestic and foreign firms in UK manufacturing industry. The results show that foreign-owned firms enjoy significantly higher levels of labour productivity and this is found to be associated with higher levels of factor usage, particularly in intangible assets and human capital in these firms, among other things. Even when input factors are controlled, foreign-owned firms are still significantly more productive than host country firms. However, foreign-owned firms are found to be less efficient than the UK-owned firms in terms of total factor productivity.

There are other interesting findings. First, the magnitude of the productivity gap varies from industry to industry. The empirical results show that the small gap in some industries coincides with the existence of significant positive spillover effects. This suggests that the presence of technologically advanced foreign-owned firms contribute to the improvements in the performance of locally-owned firms. These findings support hypothesis 4.

Second, foreign affiliates are found to pay higher wages to their workers than their local counterparts and the magnitude of wage differential is quite similar to that

of the productivity differential between foreign and domestic owned enterprises. In addition, wage spillover effects were also identified in this study, which means that a greater foreign presence increases wages in the UK-owned firms.

No evidence in chapter 7 is, however, found to support the “country-of-origin” effects, i.e. hypothesis 5. The results show that the observed productivity gap between foreign subsidiaries and local firms is not significantly sensitive to the foreign subsidiary's home country. What we do find, however, is that, the reasons for foreign superiority in performance vary across nationalities. The ownership advantages of foreign subsidiaries may take different forms, depending on the origin of home country, the relative characteristics of both host and home country and heterogeneous motivations underlying FDI in the UK. In fact, one of interesting findings is that due to the difference in nationality, not all foreign owned firms enjoy technical advantage over UK-owned firms, which is assumed to be one of the most important reasons for the out-performance. Firms from different home origins may exhibit different kinds of advantages, which enable them to outperform their UK counterparts.

Table 8.1 summarises the links between the hypotheses set in chapter 1 and empirical findings outlined in the previous chapters:

**Table 8.1 The Links between Hypotheses and Empirical Findings**

Hypotheses	Main empirical findings	Support/reject hypotheses
<b>Hypothesis 1:</b> MNEs transfer technologies from parent firms to their overseas subsidiaries, i.e. MNEs transfer technology internally. The extent of the transfer is related to the characteristics of both the subsidiaries and the parents, as well as the technology being transferred itself.	US parents' R&D has significant impact on the productivity of their Scottish affiliates, especially in product industry;; there are more technology transfers when both the subsidiary and the parent are large and have high technical level; the role of human capital in the subsidiary is particularly important in facilitating the transfer process. (Chapter 3).	Strongly support the hypothesis
<b>Hypothesis 2:</b> The entry and operation of foreign MNEs generate spillover effects in the host country industries. The spillover effects are negatively related to the technology gap and positively related to the technological capability of the local firms.	The presence of foreign-owned firms enhances the level of productivity of UK industries; spillovers take place in industries where the technology gap is small and the technological capabilities of UK locally owned firms are high. (Chapter 4)	Strongly support the hypothesis
<b>Hypothesis 3:</b> Spillovers are bi-directional in situations where the host is a developed country. The existence of the bi-directional spillovers is related to the extent to which foreign and locally-owned firms compete against each other	The level of productivity of UK (foreign) owned firms has positive impact on the level of productivity of foreign (UK) owned firms. (Chapter 5)	Strongly support the hypothesis
<b>Hypothesis 4:</b> Foreign subsidiaries enjoy higher economic performance than their host country counterparts. The performance difference can be attributed to both the differences in input proportions and spillover effects	Foreign owned firms enjoy higher productivity than UK owned firms due to they have higher level of capital intensity, intangible assets and human capital; spillovers can be observed in industries where the productivity gap is small.	Strongly support the hypothesis
<b>Hypothesis 5:</b> The economic performance of foreign subsidiaries in the host country varies by nationality, i.e. there is a country-of-origin effect. This effect is related to the different advantages enjoyed by subsidiaries from different countries	There is no significant difference in performance among foreign subsidiaries of different home origins; US affiliates enjoy higher level of intangible assets, while EU and Japan owned firms have higher level of capital intensity.	The hypothesis is rejected; but it does show that the sources of productivity advantages of foreign subsidiaries vary across nationalities.



## 8.2 Policy implications of the research

There has been extensive debate in the academic literature and by policy-makers on the role that inward investment should play in the process of national and regional economic development. The specific factors to be addressed in the policy debate on inward investment in UK for the second half of the 1990s are numerous. They include: increasing international competition for inward investment, particularly from those countries which have invested traditionally in the UK; the development of new sources of FDI from the Pacific Rim; encouraging expansion and reinvestment by MNE subsidiaries already located in the UK; and the growth in the levels of international collaboration through joint ventures and other forms of strategic alliances which are becoming more significant in the corporate plans and strategies of MNEs.

The above mentioned-policies are mainly designed towards increasing the quantity of FDI, but the quality of foreign investment deserves more attention. There is a widespread feeling that the MNEs' role in the UK economy is greater than the role played by MNEs in other comparatively developed Western economies such as Germany and Japan, but it has also been noticed that the MNE activities located within the UK have been relatively employment intensive (Barrel and Pain, 1997). Since this study concerns the indirect impact of the operations of foreign MNEs in the UK, policy implications drawn from the findings relates mainly to the quality of the inward FDI especially the associated technology transfer and spillover effects. Indeed, in terms of the impact on the longer-term development at both national and regional levels, FDI "quality" rather than "quantity" may be more relevant.

Technology transfer, spillover effects and productivity convergence are causal relationships. More technology transfer constitutes greater potential for spillovers, and larger spillovers reduce the productivity gap between foreign and local firms. To encourage more technology transfer, host country government should focus on inviting R&D intensive foreign firms, fostering R&D-friendly investment environment and encouraging development of R&D capability in foreign affiliates. It should also be pointed out that the significance of technology transfer in our study might have something to do with our defining of foreign owned firms as those of high share holding(50%). This is because that a high foreign share in a company would encourage internal transfer of technology within the MNE. A firm will prefer to adopt a wholly owned operation or acquire a majority ownership in a joint venture in order to protect and fully exploit ownership advantage (Pan, 1996). In this sense, policy makers should be aware that a relatively high foreign share in MNE subsidiary might be a good thing from the technology transfer perspective. In addition, since American owned firms are more technologically advanced than those are from Europe and Japan, special attention should be given to targeting US multinationals.

To benefit more from spillovers, policies should be designed to encourage R&D investment in local firms in order to enhance their capability to absorb advanced technology from foreign affiliates. In addition, various measures favouring competition between the two types of firms should be in place. While it can be asserted that “contagion” effects are more important for less developed countries, “competition” effects may be more important for developed countries. Increase in competition may be more effective in inducing technological change and productivity improvements than profit incentives, since “threats” of deterioration or actual

deterioration from some previous state are more powerful attention focusing devices than are vague possibilities for improvements” (Rosenberg, 1976, p. 124). The role of competition in generating spillovers will never be over-addressed.

At sub-national level, the crucial debate relates to the potential dynamic gains and the role of MNEs as “engines” of growth in a region. Turok (1993) emphasises the “quality” and dynamic nature of linkages, together with the longer-term implications for local economic development. Indeed, the extent of linkages between foreign and locally owned firms may influence the size and frequency of technological spillovers to local firms, and is likely to be positively related with the level of technological development of indigenous firms. Turok distinguishes “developmental” and “dependent” subsidiaries to identify key features of linkage development discussed in the empirical material. Young, et al (1993) analyse the circumstances under which “developmental” MNE subsidiaries may emerge in host regions. In addition, development of a population of MNE manufacturing subsidiaries that have substantial and soundly-based autonomy have also been suggested (Taggart, 1996). Subsidiaries which are more autonomous may “concentrate on extending market areas served and product lines offered, developing fully-fledged manufacturing operations, and supporting this with higher levels of R&D activity” (Taggart, 1996). The above authors highlight the importance of R&D activities and internal capabilities of the affiliates and innovation-oriented local management.

With respect to increase technology transfer from MNEs’ headquarters to their Scottish subsidiaries, the policy implications from this study are clear. Firstly, in inviting MNEs, technology policy rather than inward investment policy *per se* should

be the main driver. Surely in building sectoral or technological clusters, MNEs, because of their advanced technology, larger size and better performance, may have a central role. Secondly, organizations and agencies involved in the attraction of inward investment should continue to attract large and R&D intensive foreign MNEs especially those in the product industries. It should be pointed out that Scotland has so far been doing this but not been very successful. Lastly, the Scottish authorities should continue to devote resources to encouraging indigenous technological development. This may serve to attract inward FDI in research intensive activities (UK Pharmaceuticals is an excellent example!). The activities of MNE subsidiaries, in turn, may stimulate local rivals to a high rate of innovation due to the “competition” effect. Through such a process of cumulative causation, virtuous cycle and the expected positive long-term impact of FDI on economic development in Scotland can be achieved.

### **8.3 Limitations of the research**

The study is centred on empirical evidence regarding technology transfer, spillover effects and relative economic performance of foreign subsidiaries in the United Kingdom based on firm-level panel data sets. It shows some contributions in clarifying the issue. However, it fails to cover some important problems connected with some parts of the study especially in technology transfer and spillover chapters, owing to the limitation of the research duration. Besides this, the study itself also raises some problems. The following limitations are acknowledged:

(1) Strategic management literature on multinationals has not been fully incorporated into the research. The study is basically restricted to economics domain.

There is now extensive literature on subsidiary roles and strategies. Obviously the roles and strategies of foreign subsidiaries may have strong association with technology transfer within MNEs and with spillover effects as well. One would expect that certain types of subsidiaries would deliver more technologies and therefore more spillovers to the host country, while others would not.

(2) Omission of the subsidiary's own R&D expenditure data as input variable in the technology transfer model. In our model of technology transfer within the MNE, R&D expenditure for the US subsidiaries have not been entered explicitly as an input variable accounting for the growth of productivity due to lack of data. This could be a serious misspecification of the production function, given that there has been growing evidence of successful development of integrated high technology industries and companies and in Scotland as a whole (Taggart, 1996 and Firm and Roberts, 1984) and growing importance of R&D activities in foreign sector of the economy (see for example, Haug, et al, 1983). Indeed our model includes a variable representing the subsidiary's human capital stock, which can account for a part of the influence of R&D activities, but the omission of R&D variable may still distort the results obtained to some degree.

(3) The impact of characteristics of foreign owned firms on the extent of spillover effects has not been taken into account. The study has found that UK owned firms significantly benefit from spillover effects from the presence of technologically more advanced foreign owned firms, and we emphasized the impact of host country market conditions on the size of spillovers. However, the extent of spillovers might also be associated with the characteristics of subsidiaries. Foreign subsidiaries do

differ in for example home origins, product and sector involved, technology employed and strategic role and their relations with parent firms. These would certainly influence the size of spillovers to the host country. Certain types of foreign owned firms would have greater potential to generate spillovers, while others would not.

(4) The use of labour productivity gap to proxy technology gap. Following Kokko (1996), we have used the level of productivity to proxy the level of technology in the subsidiaries in chapter 3 and the productivity gap between foreign and UK locally owned firms to proxy the relevant technology gap in chapter 4 and 5. Admittedly productivity is a very crude proxy for the level of technology. The level of productivity might be associated with many other non-technology factors. The firm performance can in fact be decomposed into an effect from industry structural characteristics and an effect from firm competence. While technology might be the most important component of the competence, other elements of the competence, for example management skill and advertising intensity, might be less relevant to technology. It is also possible that the higher level of productivity is a result of using higher level of technology.

(5) The impact of industry structural variables on the relative performance should be explicitly taken into account. When comparing the relative performance of foreign and UK locally owned firms, we have controlled the influence of industrial distribution on the results of comparison. However, according to international economics and industrial economics literature, industry attractiveness and firm competence are both critical to international investment performance. While in this study firm competence variables are used to explain the productivity differentials

between foreign and UK owned firms, industry structural variables are omitted from relevant equations. Indeed, foreign owned firms in oligopolistic industries enjoy market benefits of entry barriers erected to new entrants and enjoy other characteristics that give them market power. Thus foreign owned firms will be affected by structural conditions in a host country and comparative advantages of these conditions as opposed to that in a home country or world market.

(6) Possible distortions in the results because of data set employed. First, the use of definition for “foreign owned firms” in the data set may “bias” the empirical results in the study. This study uses FAME database where “foreign owned firms” are defined as those of 50% or more owned by a foreign parent holding, as opposed to the 10-15 percentage definition by some other authors. Inevitably, the empirical results in this study would have been changed to some extent if we had instead taken a different level of equity ownership to define “foreign owned firms”. This is because that definition of “foreign” or “domestic” owned firms affects the relative sample size of foreign owned firms and UK domestically owned firms. The scope of foreign and domestically owned firms has particular relevance to the empirical analysis of this study especially chapters 4-7, and chapter 3 as well, although we can not predict in what directions and to what extent this would “distort” the current results in these chapters. Second, in chapter 4 and 5, we have omitted 19 sectors without FDI, this could have biased the results, as the magnitudes of the observed foreign presence ( $fp$ ) and some of other measurements of variables would otherwise have been changed.

#### **8.4 Recommendations for further research**

The recent literature (Ernst, Dieter and David O'Connor, 1992; Nohria and Garcia-Pont, 1991; Johanson and Mattsson, 1987; Ostry and Gestrin, 1993; Lan and Young, 1996;) reveals new developments with respect to international investment regime, organisational structures and innovation in multinational enterprises:

- Recent years has seen a proliferation of strategic business alliances among MNEs, both vertically along value-added chains, such as between suppliers and users, and horizontally across value added chains for different industries, such as strategic business alliances in R&D ventures. This increased co-operation has given rise to “clusters” of firms linked by various forms of contractual and financial relationships.
- The development and widespread application of information technologies and telematics in international corporate organizations. With the advent of these technologies, MNEs have been able to maintain globally accessible internal databases. These technologies have therefore served to facilitate the development of networks as well as to improve the efficiency of more traditional, vertically integrated MNEs.
- Associated with the development of information and telematics technology is the innovation-network among firms.

It is against this much changed background that the present study should lead to further developments along the following lines:



- We have examined first-round technology transfer, i.e. from parent to subsidiary. Using the same methodology in chapter 3, one can investigate the second-round technology transfer, i.e. from foreign affiliates to host country locally owned firms by examining the extent to which the growth of productivity in locally owned firms can be attributed to the use of technology transferred from foreign affiliates. While there are many studies dealing with the channel of second round technology transfer, i.e. via spillover, none of them focus on second-round technology transfer (see for example, Lan and Young, 1996 and Blomstrom and Sjöholm, 1999) which deals with the impact of the affiliate's R&D on the productivity of locally owned firms at firm level.
- The transfer of organizational skills deserves further study. As Lan and Young (1996) point out, technology is nowadays widely defined to include not only technical knowledge but also organizational know-how. Organizational technology is difficult to identify and is easily ignored by technology receivers. However, organizational know-how is required to go with production know-how (Lan, 1995). It would be interesting to examine the transfer of organizational skills across borders involving countries, particularly those of different cultures.
- Technology flow within firm networks needs to be addressed. Ostry and Gestrin (1993) developed an innovation network model. They argue that early models of technology transfer are based upon a linear conceptualization of the technology-development process where technology transfer and technology development are treated as distinct and separate processes. This model has been adopted in our

study. However, they argue that the radical transformation of the international investment regime during the 1980s has given rise to what they call “innovation network model”. A central element of this systemic approach to technological change is the rejection of the linear model and the emphasis on complex feedback loops within the system with the firm as the focal point (Ostry, 1998). It would be interesting to examine to what extent a subsidiary gets technology from innovation networks. While the costs to potential free-riders of maintaining sufficient R&D capacity to benefit from public pool of non-appropriable knowledge remain unchanged, the free-rider problem is not eliminated with the adoption of the innovation-network model. However, the overall welfare effect is positive since the lower R&D costs associated with networks offsets the negative impact of free riders upon the incentive to invest in R&D. It is interesting to investigate the extent to which the existence of networks reduces the dependence of subsidiaries on the technology of their parents.

- The growing interest in international strategic alliances and in the learning organization has evolved into a distinct line of inquiry focused on how organizations learn from their partners and develop new competencies through strategic alliances. There are some recent investigations regarding how knowledge is transferred across partners (Appleyard, 1996; Baughn, et al, 1997; Choi and Lee, 1997; Dodgson, 1996; Mowery, et al, 1996). However, there are no studies investigating the extent to which a foreign subsidiary benefit from a strategic alliance to which it affiliates with respect to technology. While parent firms may be the main source of technology for subsidiaries, there may be opportunities as well for these subsidiaries to obtain technology from other subsidiaries within the

same strategic alliance. Therefore investigation the impact of technology flow within strategic alliances on the level of technology of foreign subsidiaries would be a promising stream of research with respect to technology transfer associated with FDI.

- Porter(1990) emphasises the impact of the home country environment on a firm's competitive advantages. This is however challenged by Rugman (1993) who argues that, given that multinational subsidiaries benefit from "techno-globalism" and global scope economies, they are becoming increasingly independent from individual countries. We have measured the productivity gap between foreign and locally owned firms, and we have focused on the determinants explaining this gap. It is reasonable to assume that to some extent this gap should be a reflection of the overall productivity gap between the host and the home country concerned, i.e. the "gap" between the above two gaps. It is interesting therefore to examine the extent to which the productivity gap between the two countries affect the productivity gap between the subsidiaries of that home country and the locally owned firms.

## **Appendix: Data source**

The data used in this thesis is mainly taken from the FAME database. In this database coverage is divided between two discs: disc a and disc b. Disc a contains any company which has turnover greater than £75,000 but less than £500,000 (and other criteria), and there are approximately 110,000 such companies. Disc b contains additional companies having a turnover greater than £500,000 (and other criteria), and there are approximately 100,000 such companies. Companies meeting the above criteria are included as they are identified and are categorised as either JW (Jordan Watch) companies or JS (Jordan Survey) companies.

The database also contains descriptive data concerning other British companies of a JW or JS Company. These companies are called OS (Other Subsidiary) companies or OH (Other Holding) companies. Still the database gives the name of the company where each foreign holding company mentioned in the database is located; these companies are called FH (Foreign Holding) companies. There are nearly 60,000 OH, OS or FH companies. Thus the database has information concerning approximately 270,000 companies.

Other data are mainly taken from the following sources:

- (1) Economic Trends, the Office for National Statistics (ONS), 1997 Edition, London, HMSO.
- (2) Economic Trends, the Office for National Statistics (ONS), 1996 Edition, London, HMSO.
- (3) Main Economic Indicators, OECD, 1996.

- (4) Overseas Companies Operating in Scotland 1995/96 Directory: published by Scottish Enterprise, 1997.
- (5) The Blue Book: Published by HMSO, London, 1996.
- (6) US parent company reports to US Security and Exchange Commission (SEC): published by Q-data Corp in the USA in microfish form.

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